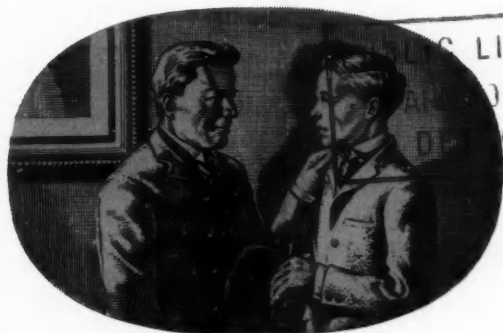


The Chemical Age

OL LXIV

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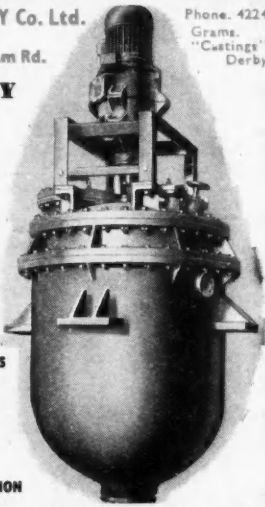
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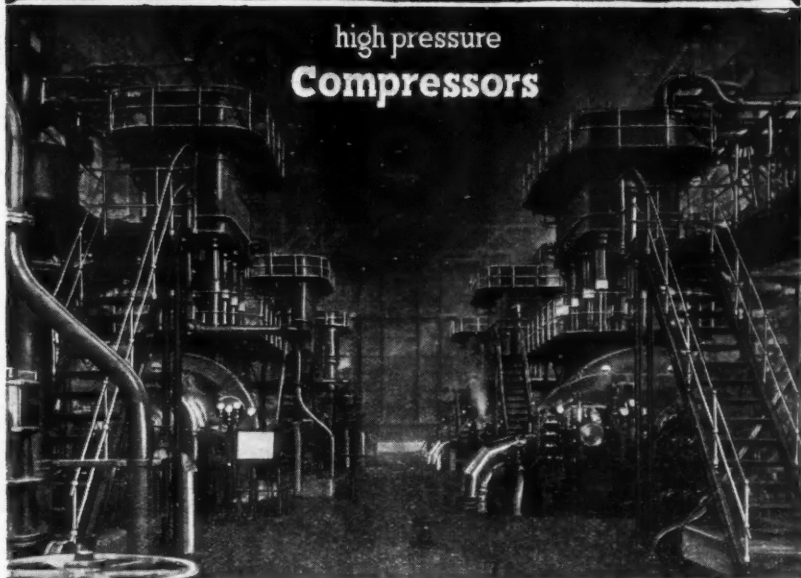
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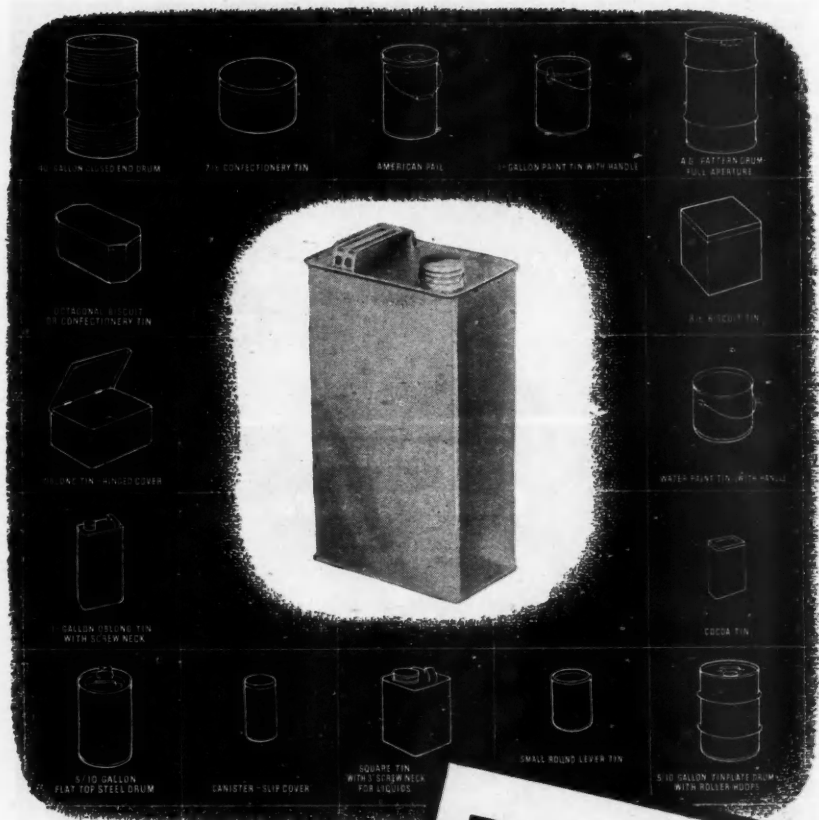


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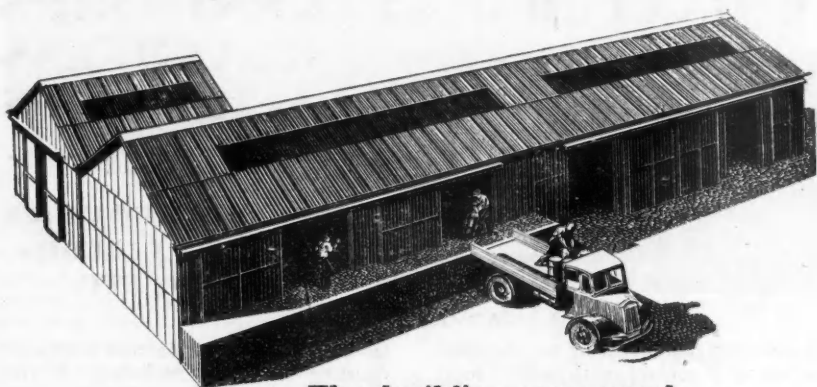
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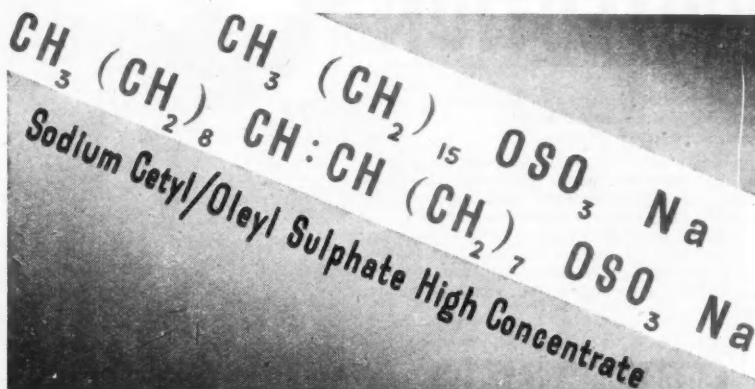
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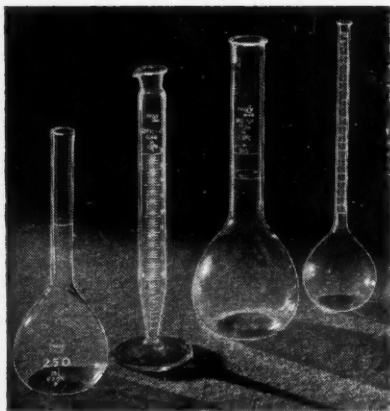
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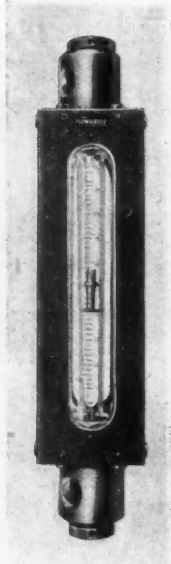
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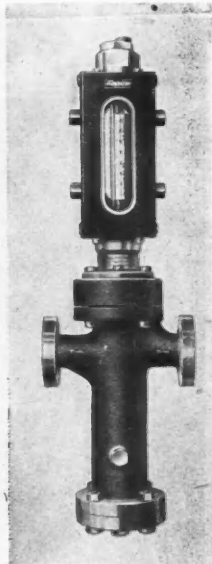
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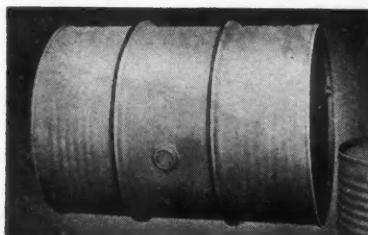


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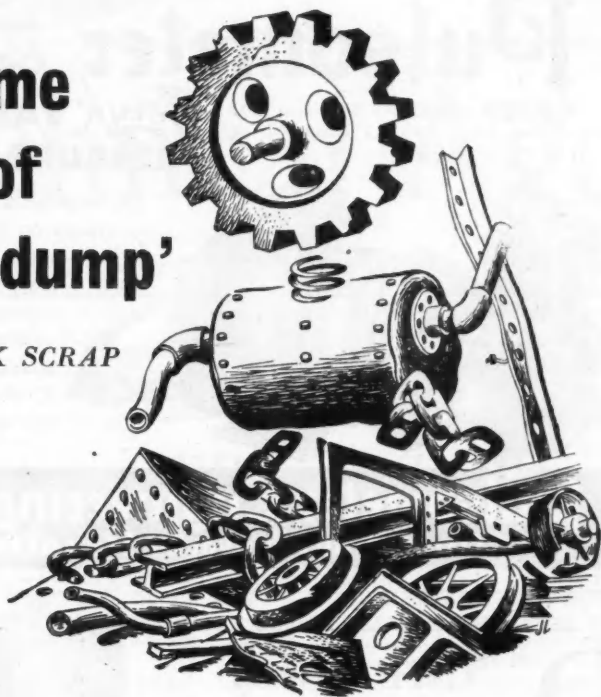
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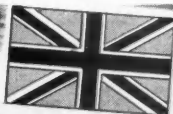
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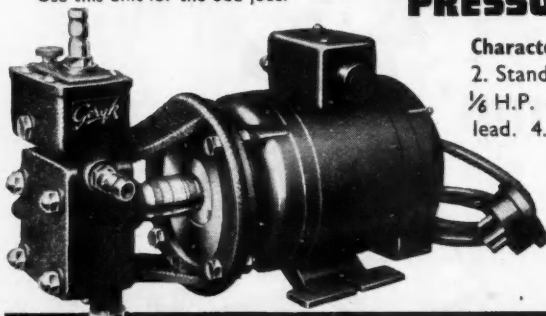
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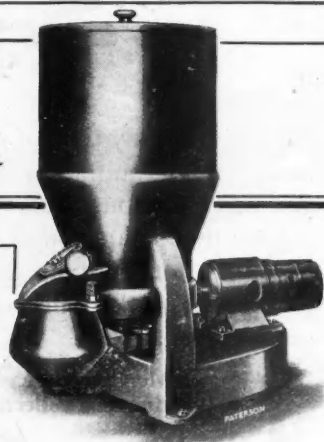


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Volume LXIV

14 April 1951

Number 1657

Brimstone—Without Treacle

MANY people nowadays spend their time thinking that if only others would give them their due, everything would come right, but the present sulphur shortage is a situation to which there is no pleasant Santa Claus solution.

The fact that a supplementary allocation of 19,000 tons has recently been made to us should not be regarded as a token of continuous relief nor as a hope that diplomacy or politics can sweeten a harsh situation. The 19,000 tons can, and may well be, taken off future allocations; it is immediate sustenance for today borrowed from tomorrow. From time to time the smallness of Britain's total needs is compared with the huge total output of American sulphur. The cuts imposed upon our former rate of import may, viewed from this angle, take on the semblance of drops in the ocean, but no approach to the problem could be less realistic. We must follow Burns' precept and see our sulphur needs as others see them, and particularly as American manufacturers see them. Here, for example, as a recent recommendation from a sub-committee (for agriculture) of the U.S. House: 'That the export programme be critically reviewed with the objective of finding out how much American sulphur the industries of other countries can do

without—not how much they would like to have.' In the same report it was complained that E.C.A. had made no real efforts to get European industry to use Spanish pyrites rather than sulphur as its source of sulphuric acid. 'In the event of war, European industry would probably have to depend almost entirely on European sources . . . It would appear to be the course of prudence, therefore, to make the shift to these sources now.'

It is not so much these statements themselves that should be considered, as the background to them. It is the background of American manufacturers themselves already feeling the pinch of sulphur shortage. The most optimistic estimate of 1951 output of U.S. sulphur is 5.7 million tons. The figure previously taken for post-war years is less, not much above 5 million tons. Against this, the estimated need or demand from American industry is 6 million tons. It is not unnatural, therefore, that there should be considerable resentment at the export of 1.2 million tons, and the general cut of one-third which has been made is not considered to be enough. In maintaining even these reduced allocations the U.S. Government has been under heavy fire. No one this side of the Atlantic should look upon the figure of 5.7 million tons of sulphur as a statis-

tic of plenty. It is not. The United States is a vast industrial country. She built up her own sulphur industry as a defence against monopoly exploitation by European producers of sulphur. American sulphuric acid plants have been designed to run on American sulphur. Changing over to pyrites is a painful operation, both costly and cumbersome; nevertheless, acid plants in the United States are today changing over to pyrites. Nor should it be supposed that it is only in Europe that reductions in the use of acid-based phosphatic fertilisers are being planned. An agricultural committee in America has recommended that compound fertiliser formulas should be re-shuffled 'to reduce the phosphate applications to those crops which can temporarily get along on smaller amounts of this plant food.' A survey of methods for making phosphatic fertilisers without H_2SO_4 appeared in the U.S. journal, 'Agricultural Chemicals', in December, 1950; at least this shows an early and practical reaction to the sulphur position in America.

Over and above the immediate position there hangs, too, the grimmer future for American sulphur, the steadily approaching exhaustion of the Gulf Coast salt-dome reserves. This certainty was discussed here a few months ago (CHEMICAL AGE, 63, 1640, 849-50). The greater the annual rate of mining now, the shorter the future of the Frasch-mined sulphur deposits. Notable efforts

are being made to produce more sulphur. Previously unworked domes in Louisiana lying under marsh water are to be Frasch-mined from barges. Hydrogen sulphide wastes from sour natural gas streams have formerly been burnt; sulphur recovery processes are now to be applied. A new mechanised process is being applied to low-grade sulphur ores. Should this succeed in overcoming the difficult economics of low-grade ore working, the supply centre of sulphur may well shift to the Andes.

Here again it is the background to these developments that must be realistically considered. The U.S.A. could pursue an isolationist sulphur policy. For some years her low-cost Frasch production could meet most of her own needs. Instead, a vigorous policy of economy in use and of developing new and more costly sources of sulphur and acid is being urgently followed. European pleas for less stringent allocations must inevitably be examined with 'means-test' caution. A very rich man can be careless in dispensing charity. A man already practising considerable and painful economies himself is right to consider whether requests for help come from those who are relatively more wasteful. It is sheer wishful thinking to suppose that diplomacy or high-level politics can sweeten the brimstone story with treacle. The situation is one of hard facts and inescapable figures. It will not be altered by words or bargains, but only by technical actions and technical events.

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Notes & Comments

Of Mice & Men

TO many people, any connection between the Dome of Discovery on the South Bank Exhibition of the Festival of Britain and a mouse trap would not be immediately apparent. Yet these two extreme examples of man's constructional ingenuity both illustrate the manifold applications of aluminium. The Dome we in Britain shall soon be able to investigate for ourselves, but as to the advantages of the mouse trap, these must, at any rate for the time being, be accepted as described in the current issue of *Aluminium News*, published by the Aluminium Union, Ltd., Montreal, Canada, as it has been marketed in Michigan, U.S.A. This novel gadget is claimed to be fool-proof as far as inquisitive babies and pets are concerned, but it is feared that any special features might well be offset from the Englishman's point of view, as for its successful operation he would have to sacrifice his week's cheese ration! Lest this should seem to be treating aluminium too lightly, still another use of this metal is illustrated by its part in lightening the load of musical conductors by means of a tapered aluminium baton made of suitably shaped alloy sections. Such a baton would indeed seem to be highly appropriate for the proper conducting of the Royal Festival Hall concerts.

Science in Schools

SCIENCE in Secondary Schools, a small booklet recently published by the Scottish Education Department contains within its few pages the very essence of science, and it is to be hoped that all who teach chemistry in our schools, whether south or north of the Tweed, will absorb two particular passages. The first deals with the aim of experimental work in teaching. It is said '(1) every experiment should have a definite aim appreciated by the pupils—the statement of this aim should not anticipate the result of the experiment; (2) the pupils should be led to take an active part in the planning of

the experiment or series of experiments, and in the selection of appropriate apparatus . . .'. How often must chief chemists in industry have wished that graduates from our universities had absorbed these two principles of scientific method as thoroughly and diligently as they had absorbed so many detailed frills of science. Facts can always be looked up and it is only necessary to know where to do the looking. Far too often the end-product of our educational systems, the young graduate, must be taught how to design new experiments that may shed light upon new problems. The second passage is concerned with the description of experiments. 'Reports should state clearly (1) what was done, (2) what was observed, and (3) what was learned from the results. (1) and (2) should be written down as the experiment proceeds; (3), if simple, may be written down at once, but usually will be recorded only after some discussion.' This seems so simple that it might be regarded as trite. But again how often the young graduate seems able to write an accomplished essay upon the previous work of scientists, but alarmingly unable to report in a concise and properly ordered manner upon new work of his own. If future pupils in Scottish schools are indeed introduced to scientific subjects according to the principles set out in this publication, many of the difficulties involved in later technological education will be dissolved.

Apathy in Industry

IS the welfare state a menace to individual endeavour? Far too often it would seem that the cushioning of the worker from the cradle to the grave has not brought added happiness or zest, but merely infected industry with a dangerous form of collective boredom. This indeed is the view of Mr. Ian Fergusson, chairman and managing director of Evans Medical Supplies, Ltd., who is the subject of its 'Man of the Month' feature in the April issue of *Scope*. Mr. Fergusson is a great-great-grandson of the original founder of the

firm, one of the world's most important manufacturers of drugs, fine chemicals, biologicals, veterinary products, pharmaceuticals, culture media, etc. In 1941 the works at Speke, Liverpool, were destroyed during an air raid, and it is mainly due to his vision and energy that the factories are today a show place for industrial architects and engineers from all parts of the globe. Mr. Fergusson, besides being an industrial leader and a keen student of economic and social problems, is essentially a humanitarian. Industry's greatest problem today, he thinks, is apathy. Nevertheless he is optimistic for the future and believes that in spite of the morass of sameness and uniformity which seems to be due to the welfare system, men of originality and dynamism will emerge.

Greater Understanding

CHEMISTRY permeates modern civilisation as does no other industry. It is esoteric and to the layman tends to seem mysterious and somewhat alarming—there is no aspect of life which is not affected by it. Any attempt to dispel such fears by a greater understanding of the chemical industry and its achievements deserves encouragement. The vital rôle chemistry has played in the past and its importance to the future of the civilised world are told and illustrated in an article entitled 'the Age of Alchemy' appearing in the current issue of 'Power to Spare', the house magazine of Oldham & Son, Ltd., Denton, Manchester. To those whose interests are industry and history and the strange romantic tale of Britain's commercial development, the chemical industry looms large. It is good, therefore, to find an appreciation of its research and development, which is responsible for the well-being of the people, brought home to the ordinary man in simple and dramatic form. One of the great problems of the industry is, indeed, that of continuous advancement. Plant and equipment installed at considerable expense today, may become out-of-date almost before completion. But despite shortages of every kind—from qualified scientists to raw products and building materials—the British chemical industry is proving itself vigorous, enterprising

and aware and capable of discharging its responsibilities.

Saving Your Skin

YET another recruit is added to the ranks of dangerous chemicals today with the growing use in industry of hydrofluoric acid. Already well-known in the glass and pottery industries, this highly corrosive acid is tending to become of increasing importance in the oil industry, in the production of certain motor fuels, as a rust-remover, in plastics, silk dyeing, refrigerants and probably a host of other fields. Like many another chemical disfigurer, however, the special characteristics of the new visitor and the treatment which must be accorded to its burns is sometimes not fully realised by the casual user until it is too late. Each member of the Corrosive Brigade has its own particular form of unpleasantness ready to macerate human flesh, and hydrofluoric acid is no exception. 'Acid?' asks the M.O.—'Right, fetch the bicarb.' Unfortunately it is not the hydrogen ion in this acid that does the damage. The fluorine ion, if allowed to penetrate the system either in one big dose or many small ones (and fluorine gas becomes converted into HF in water) may cause tracheitis, bronchitis, pneumonitis, or pulmonary oedema if inhaled. Its acute irritant effect forms extensive surface coagulation which completely prevents the penetration of external medication, and necrosis underneath, which must be treated immediately by an injection of 10 per cent calcium gluconate, frequently a very painful operation. The British Medical Journal attaches so much importance to this that it says local or even general anaesthetic should be administered if there is any chance of the patient being unco-operative through pain or fear. Soaking the burn in 70 per cent alcohol and ice for one hour is recommended in America, and magnesium oxide paste is said to be of no use except on very slight burns as a first aid measure. The only treatment for inhalation of the element is evidently prolonged oxygen inhalation, and workers using this material, say the B.M.A., should be radiographed regularly to detect small doses.

Recent Pyridine Research

Investigation of Hydrogenation By-Products

TWO years ago workers at the Chemical Research Laboratory became interested in the liquid phase hydrogenation products of pyridine. They observed that some hydrogenolysis occurs with Raney nickel as the catalyst, yielding small quantities of certain high-boiling bases in addition to the piperidine. Increasing the temperature and the time of contact led to higher yields of the hydrogenolysis products at the expense of piperidine. When piperidine was heated at 230-250° for 12 hours with 10 per cent of its weight of Raney nickel, only 9.3 per cent survived, the total yield of liquid product—including unchanged piperidine—being 94 per cent. Distillation of the liquid product gave fractions covering a very wide boiling range. These were found to consist mainly of tertiary bases, but some secondary and primary bases and pyrrole derivatives were also present.

Four major constituents have been identified, namely *N-n*-butyl-*N-n*-amyl- and *N-cyclopentyl*-piperidine, and 1,5-dipiperidino-pentane. These have been isolated and characterised as picrates, hydrochlorides and methiodides. The formation of these tertiary bases from piperidine may be interpreted in terms of hydrogenolysis of piperidine with subsequent reaction of the primary products with unchanged piperidine. More detailed examinations of the final products were undertaken in order that the highly complex reactions might be more fully understood.

Significant Feature

A significant feature of these high-boiling bases is their biological activity. High-boiling residues both from the hydrogenation of pyridine and the treatment of piperidine with Raney nickel proved toxic to grain weevils. A systematic biological evaluation of these materials was therefore undertaken by the Pest Infestation Laboratory, DSIR, in order to ascertain what compound or group of compounds was responsible for the insecticidal activity observed.

In the first place a series of fractions obtained by a rough vacuum distillation of the product remaining after heating piperidine to 250° for 12 hours with 10 per cent Raney nickel and hydrogen, was tested for knock-down effect and lethal action. Within the

range 50-70°/5 mm., the samples showed little or no toxicity. From 70 to 86°/5 mm., knock-down was rapid but non-persistent and lethal action relatively small. Among the identified constituents occurring in this group of fractions were *N-n*-butyl piperidine, *N-n*-amyl piperidine and *N-cyclopentyl*-piperidine. Samples from the distillation range 86-185°/5 mm. gave slower knock-down, becoming 100 per cent effective at 6 hours and being followed by lethal effects reaching 100 per cent in 72 hours. A prominent constituent of the higher boiling fractions is 1,5-dipiperidino-pentane.

Synthetic Specimens

For comparison, synthetic specimens of the four constituents mentioned above were prepared at the Chemical Research Laboratory and were submitted to the same test. The results showed that the observed knock-down effect on grain weevils could be attributed to the presence of *N-n*-amyl-piperidine and *N-cyclopentyl*-piperidine in the crude fractions, 1,5-dipiperidino-pentane being responsible for the eventual high mortality.

Since the insecticidal properties of *N*-substituted piperidine derivatives did not appear to have been systematically investigated, it was decided to synthesise for evaluation two homologous series of tertiary bases of this type. Compounds of the *N*-alkyl-piperidine and *N,N'*-polymethylene-dipiperidine types were given preliminary screening tests with grain weevils. The results yielded some interesting evidence of the dependence of biological activity on molecular structure. In the *N*-alkyl-piperidine series, for instance, amyl and hexyl had a rapid knockdown effect but little lethal action. Heptyl and octyl had knock-down effects of 100 per cent and 97 per cent respectively in one hour and lethal action which proved 93 per cent and 100 per cent effective at 24 hours under the conditions of test. There appeared to be a definite correlation between insecticidal behaviour and the length of the alkyl and polymethylene chains in these two series.

The biological tests were extended to cover a wide range of other *N*-substituted compounds, and again certain correlations between structure and activity were discernible. In order to compare the insecticidal

potency of the more active compounds with that of established insecticides, a further series of tests was initiated. The performances of octa-N-methyl-pentaerythritylamine and N-n-heptyl-piperidine were compared with those of the pyrethrins, DDT and gamma-BHC in Shell oil P.31, with encouraging results.

Workers in the field of coal tar bases have been handicapped by the absence of specific colour reactions for the detection and estimation of bases of the pyridine series. New qualitative tests based on the use of phenol-chloroform-sodium ethoxide mixture have recently been developed by E. F. G. Herington. The strongest and most characteristic colours obtained were with phenol itself, p-chlorophenol or thiophenol. The presence of as little as 0.1 per cent of α -picoline in β -picoline or 2,6-lutidine can be detected with the phenol reagent, while 0.0005 ml. of γ -picoline produces a detectable colour if other bases are absent. The reagent containing thiophenol yields particularly brilliant and characteristic colours suitable for the identification of single bases.

Readily Separated

Simple fractional distillation by modern distillation techniques will readily separate α -picoline and pyridine from a mixture, but the homologues β -picoline, γ -picoline and 2,6-lutidine boil at nearly the same temperature, so that other methods have to be used in their separation. For this reason, special attention has been given to the analysis of these close-boiling mixtures. A reagent containing 1-chloro-2,4-dinitrobenzene, acetamide and 2,6-lutidine permits the quantitative estimation of β - and γ -picoline in a mixture with 2,6-lutidine.

Industrial firms have experienced difficulties on various occasions in hydrogenating fractions of pyridine, due to the presence of some poisons in commercial fractions. In this connection reference may be made to the work on catalyst poisons which has been carried out at the University of Bristol. The self-poisoning effect in the hydrogenation of pyridine was the subject of a paper by E. B. Maxted and A. G. Walker. Pyridine, even when free from sulphur, undergoes catalytic hydrogenation at a considerably lower rate than, for instance, benzene under similar conditions. It appears probable that its low hydrogenation rate may be connected with the influence of its nitrogen atom. Maxted

and Walker discussed this effect from the standpoint of electronic conditions, which are known to govern catalyst toxicity in that when free electron pairs exist in the valency orbits of the molecule, toxicity increases, and when the derivative has a shielded structure it disappears.

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Sulphur from Bacteria

MICRO-BIOLOGICAL production of sulphur was referred to in the recently published DSIR report for 1949-1950 as one of the methods being investigated to help in overcoming the sulphur shortage.

A survey of four desert lakes in Tripolitania and Cyrenaica was carried out last year by two British scientists, Mr. K. R. Butlin and Mr. J. Postgate (THE CHEMICAL AGE, 63, 329). Samples were taken and brought back to the Chemical Research Laboratory, where the formation of sulphur has since been reproduced by appropriate bacteria. Attempts are now being made to speed up the process.



Mr. K. R. Butlin examining some of the bacteria in the large incubator at the Chemical Research Laboratory, Teddington

Outlook for Italian Sulphur

Chance for Revival and Modernisation

SULPHUR production is an old industry in Italy, dating back as far as the seventh century according to some documents. Its first real boom came, however, with the adoption of fire-arms, and another, during the Napoleonic wars. Production of sulphuric acid also fortified the demand for this product.

In 1900 the Italian sulphur industry reached its greatest prosperity. By then Italy was producing at the rate of 550,000 tons a year which represented about 94 per cent of the world output. About 90 per cent of this quantity was produced in Sicily where there were then 107 active sulphur mines employing some 40,000 men.

Everyone then bought Italian sulphur, the United States alone importing some 100,000 tons annually, mostly from Sicily.

At the start of this century, however, important sulphur beds were discovered in Texas and Louisiana, and America started producing for herself, later developing an export trade. This spelt the doom of the Italian sulphur industry, which began to decline, and in little less than half a century was reduced from a predominant position to obscurity.

By 1925 Italian output accounted for only 20 per cent of the world output, and the number of active mines in Sicily dwindled to 80, while the number of workmen was reduced to 10,000.

Continuous Decline

After that it became a story of continuous decline as can be judged from the figures below:—

	1933	1934	1935	1947
Total Italian output of sulphur (in tons)	376,623	343,388	310,399	166,676

American competition was responsible for this. The mines in Texas and Louisiana adopted the Hermann-Frasch process which enabled them to produce sulphur at about half or less of the Italian price. Italian mines were not able to adopt the same process for two reasons: (a) American sulphur is found in a practically pure state, while in Sicily it is found in layers 30 metres thick thoroughly mixed with chalk, limestone, clay and other impurities; it is only rarely that ore is worked with as much as 40 per cent of pure sulphur,

and about 15 per cent is the average in Sicily; (b) Americans have supplies of cheap petroleum close to their sulphur mines, while in Sicily fuel of any kind is very costly. In any case the capricious nature of sulphur veins in Sicily practically precludes the use of Hermann-Frasch process.

Some understanding with Americans was sought by the Italian producers, and an agreement was made between the Sicilian Sulphur Consortium and the American Union Sulphur Company, whereby 66 per cent of the output was assigned to the former and 33 per cent to the latter. This was at first abided by, but later the American company went ahead indifferently.

Becoming Impoverished

Meanwhile it became evident that the Sicilian sulphur mines were getting impoverished. Indeed, it is clear today that while the sulphur content of the ore obtained from the Grottacalda mine once reached 35 per cent, it has now been reduced to some 17 per cent. In the case of the Tallarita mines the yield has decreased from 23 per cent to 9 per cent. Once the Trabia-Tallarita group produced nearly 70,000 yearly tons; this has been reduced to hardly 20,000 tons. The Grottacalda mine which produced 25,000 yearly tons, has had to be abandoned.

No steps seem to have been taken to rectify the position, and Italian producers either simply appealed in vain for Government subsidies or went silently out of business. Gradually many Italian economists came to the conclusion that there was no remedy and that the sulphur industry in Sicily was fated to diminish to the limits set by the local consumption.

Recent changes in the international situation, however, have created new hopes for Italian sulphur. The United States is limiting its exports. There is a world shortage of sulphur.

This means that European countries will be forced to buy Italian sulphur in spite of its high cost.

First results of this new situation have already begun to be felt and during the first ten months of 1950 about 208 per cent more sulphur (180,914 tons) were exported than

during the corresponding period of 1949 (58,084 tons). The progress was even more marked by the end of the year when a total of 239,526 tons of exports was reached, registering an improvement of some 227 per cent over 1949 (73,118 tons). This figure, incidentally, exceeds by about 4 per cent the exports of 1938.

Drastically Reduced

The effect on the stocks with which Sicilian producers had been burdened, was like magic, and stocks were reduced as follows at the principal Sicilian storage deposits:—

	1949	1950
Porto Empedocle	60,346 tons	34,921 tons
Licata	75,332 "	15,976 "
Catania	11,606 "	3,599 "
Termini	5,695 "	1,989 "
Total	152,979 tons	56,485 tons

In 12 months the Sicilian stocks of sulphur were reduced by approximately 63 per cent, a very consoling phenomenon for any producer, and all the more so to Sicilian mines as such large stocks meant for them the freeing of about 73 per cent of their year's output.

Looking at the statistics of the last five years we find that the Italian output has been increasing steadily (in tons) as follows: 1947—166,676, 1948—189,600, 1949—208,068, 1950—230,000 (approximately).

During the current year the output will in all probability be increased further, but the most important problem for Italian sulphur mines is not how to increase the output—this could easily be achieved by engaging more workmen—but how to produce sulphur at a price that could be compared with the American.

In the present political contingency this problem seems to have lost much of its importance for people will buy expensive sulphur if they cannot get the cheap one. Italian leaders feel, however, that mere profiting from temporary difficulties of others would not be a far-seeing policy and that this lucky opportunity should be used to put Italian sulphur industry on a more modern basis. Consequently hundreds of technicians have been set the task of studying the problem in all its aspects.

There is no denying the fact that from technical point of view sulphur mining in Italy, and especially in Sicily, is behind the

times, and this has, indeed, been so from the very beginning when the mining law then in force created unfavourable conditions. This law (by now repealed) stated that every landlord owned also the contents of the subsoil under his plot of land. Thus, countless small landlords leased their subsoil rights to jobbers and consequently a large vein of sulphur was tackled by numerous small mining concerns none of which had enough capital for rational exploiting.

In many Sicilian mines sulphur is still extracted and processed along the methods that were old 50 years ago. Then there is lack of means of transportation, so that to get the sulphur obtained to seaports, recourse is still taken in many cases to human backs—with results to cost that can easily be imagined! Even so, most of the ports used are so shallow that direct loading from quays is impossible and manual loading into barges is a daily occurrence. A study carried out in 1936 showed that the cost of transportation of sulphur to a boat represented 16 per cent of its total price.

To-day the situation is worse, if anything. Many of the sulphur beds in Sicily are flooded and not possessing adequate pumping machinery, the mine owners turn to other layers even if they happen to be much poorer. A typical example is the mine at Gelsolungo where the richest part of the sulphur bed is flooded and the management is forced to exploit a poor worn-out layer. There is a solitary electric pump chugging optimistically at a vast sheet of water some 40 feet deep, but it seems more a matter of principle than a practical measure.

Shortage of Power

The fact is that there is not enough electric power in the district. Some excellent sulphur beds cannot be exploited because the nearest power line is 10 miles away and the owners have not enough capital to pay for an extension. Thus, while the sulphur district spreads over some 5,000 kilometers, only a tenth part of it or so can be exploited.

In most of the Sicilian mines ventilation is of the most rudimentary kind and the air in them is so vitiated that it reduces the energy of workmen and thus the output per man.

The present method of processing sulphur is not adequate to-day, for the Gill furnaces used burn and destroy from 33 to 40 per cent of the sulphur content of the ore. Recourse to the flotation process has been

suggested, but to introduce it requires considerable supplies of water and machinery.

Numerous programmes and studies intended to modernise the Sicilian sulphur industry have been already prepared and the Government has come to the rescue with a grant of 9,000 million lire for Sicilian industries.

Although much can be done to modernise the Sicilian sulphur industry it must not be forgotten that its mining costs can never be reduced to the American level for the Americans have at their disposal thick layers of almost pure sulphur, while Sicilian miners have to grope among all sorts of debris in capricious geological strata which are often filled with water and present a real danger in the shape of highly explosive fire-damp or poisonous sulphuretted hydrogen.

Scientists, however, have indicated a remedy for this aspect of the situation by further prospecting. They point out that all Sicilian mines originate from the easy old days when prospectors had no great technical assistance and looked naturally for accessible sulphur beds near the surface.

To-day most geologists agree that more sulphur beds can be discovered in Sicily. It has been reckoned that while the consistency of the exploited surface layers of sulphur amounts to some 1,300 sq. kilometres, the consistency of deeper (and not yet exploited) layers totals from 3,000 to 3,500 sq. kilometres. Moreover, there is every chance that many of the deeper layers are exceptionally rich in sulphur content.

First Atomic Energy School

A FURTHER step towards making the manifold uses of isotopes better known to research workers in science and industry was taken last week when Sir John Cockcroft, director of the Atomic Energy Research Establishment opened the new school at Harwell for the first course in radiochemistry.

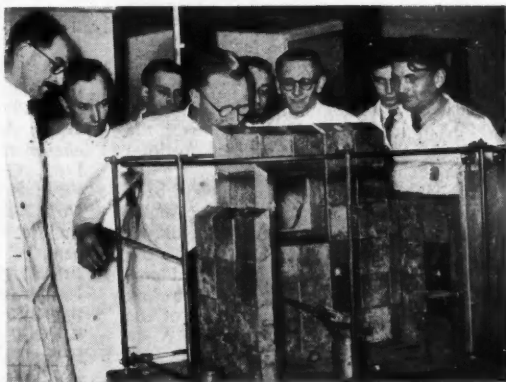
In this experimental series of lessons, which will last for six weeks, there are eight pupils. Some come from the research departments of rubber, sugar, diamond producing, and flour milling trade associations, while others are Government scientific workers.

The new school is at present housed in a converted hut, but it is hoped that there will soon be permanent premises. During the first week students will be taught elementary nuclear theory, after which the lessons will become progressively specialised.

Future courses will last one month, and a fee of £40 will be charged, exclusive of accommodation. Students will live in the hostel at Buckland, about 14 miles from Harwell.

Most of the students taking part in this first course have a comprehensive knowledge of advanced technique in matters like laboratory electronics. Two stated that they hoped to introduce isotopic research methods in their own trade associations. A laboratory for such work could, according to Sir John Cockcroft, be set up for about £500.

Dr. J. E. Johnson, of Harwell's Isotope Division, demonstrates a simple remote handling device for radioactive solutions



British Chemical Plant Industry

Problems of Defence Programmes and Shortages

THE desirability of the chemical plant industry carrying on as far as possible with normal production was emphasised in the report of the British Chemical Plant Manufacturers' Association for the year ended 31 December, 1950, which was presented at the recent annual general meeting.

At the close of last year the full impact of the Defence Programme had not yet been felt, but the association does not want to see its members, at this stage, having to take on defence projects which are not of a chemical engineering nature, and which would upset their production plans, slow down supplies to the home chemical industry and considerably weaken their position in export markets which they have developed so assiduously since the war.

Raw Materials Set-back

Problems of raw materials and supplies which had shown signs of improving, were again disturbing by the end of the year, particularly in such materials as stainless steel, aluminium, copper and brass. Shortages came upon the country suddenly, and although the Government departments were undoubtedly trying to keep industry informed, there was little information available.

To obtain a clear picture of the position in the industry as a whole and a knowledge of individual members' supply problems, a questionnaire was issued to all full members during December.

German recovery and the fact that she is again becoming an active competitor was emphasised at the Achema IX, German chemical plant exhibition held at Frankfurt-on-Main in July. Technically, however, the British industry could face this competition with confidence.

Although the association has always been in touch with the U.K. section of the Anglo-American Council on Productivity, the diffuse range of specialist interests had not made a BCPMA productivity team a practical proposition. The opportunity had therefore been welcomed of including three of its members in the team sent to the U.S.A. to study welding.

Oral and written evidence was given by

the association to the Chemical Engineers' Sub-committee on the Present and Future Supply and Demand for Persons with Professional Qualifications in Chemical Engineering, the report of which was published in September. Statistics relating to employment of chemical engineers in the chemical plant industry stated that the number employed in 1949 was 239 compared with 60 in 1938, and estimated a requirement of 348 by 1954.

Total exports of the chemical plant industry are difficult to assess from published statistics, but an indication of its contribution to the export drive is shown by the figures of 'Gas and Chemical Plant' taken from the *Trade and Navigation Accounts of the United Kingdom*:

	£ million	Tons
1947 ...	0.9	5,389
1948 ...	2.21	10,370
1949 ...	3.71	15,591
1950 ...	3.14	12,685

The fall from the peak figure of 1949 was partly due to the completion of large contracts obtained in the immediate post-war period.

At the end of the year preparatory work had been completed on the next issue of 'British Chemical Plant,' the association's illustrated directory of members, and printing was about to begin. It will be similar in format to the previous issue, but some 40 per cent larger.

New Officers Elected

At the annual meeting the following officers and council were elected for 1951:—*Chairman*: Major V. F. Gloag, M.C. (Simon-Carves, Ltd.). *Vice-chairman*: E. S. Franklin (Torrance & Sons, Ltd.). *G. N. Hodson* (Hathernware, Ltd.). *W. J. Hooton* (S. H. Johnson & Co., Ltd.). *Hon. Treasurer*: P. W. Seligman (The A.P.V. Co.). *Council*: W. R. Beswick, B. L. Broadbent, H. W. Fender, Dr. G. E. Foxwell, K. Fraser, N. C. Fraser, A. G. Grant, J. C. Haithwaite, A. M. Hutcheson, R. Lessing, B. N. Reavell, J. Arthur Reavell, G. W. Riley, R. W. Rutherford, Dr. R. Seligman, E. Smith, R. F. Stewart, J. W. Wright, and H. V. York.

Carbon Disulphide

A New By-Product of the Oilfields

AMONG the growing list of chemicals produced commercially from natural gas, carbon disulphide is the most important recent arrival. At the time of writing, at least one plant is actually in operation in the United States which synthesises carbon disulphide by the reaction between methane and sulphur vapour. Economic results are encouraging and promise effective competition to the established methods of carbon disulphide production by the interaction of coke with sulphur at elevated temperatures in a continuously operated vertical retort.

The potential market for petroleum-derived carbon disulphide is tremendous. This compound, which finds important outlets in the textile (rayon) industry, in the production of carbon tetrachloride and in a number of other industries, was produced in 1943 in the United States alone to the extent of 280,000,000 lb. By 1950, production of carbon disulphide had risen to 364,000,000 lb. with a continued trend upwards. A similar growth curve is exhibited by the carbon disulphide industry in other industrialised nations.

Special importance attaches to the production of carbon disulphide from petroleum gases in oil-fields which produce sour (hydrogen sulphide-rich) natural gases. In almost every such instance, it is necessary to remove hydrogen sulphide from the hydrocarbon gas before it can be effectively utilised for cross-country shipment or for local fuel purposes. Regardless of the method of purification employed (sodium carbonate scrubbing, Girbitol or Alkacid washing, etc.), a by-product stream of relatively concentrated hydrogen sulphide is obtained which, by itself, represents a serious nuisance problem to the refiner.

Usually Burned

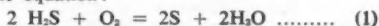
Conventionally, this by-product hydrogen sulphide has been burned, either for fuel in specially constructed corrosion-resistant boilers, or for waste in flare stacks. In either case, the flue gas discharge must be at sufficient distance from domestic or commercial vegetation to prevent serious damage due to by-product sulphur dioxide.

More recently, effective methods have

been developed for the direct commercial conversion of hydrogen sulphide to sulphuric acid. The plants employed for this process are, however, on the whole more costly than standard sulphur-burning sulphuric acid plants. At the same time, the product sulphuric acid is severely limited in the concentration which can be achieved and such a plant is only suitable where there is a sufficient market for dilute sulphuric acid within the economic shipping radius to justify the erection of a 50-100 ton per day sulphuric acid plant. This is about the smallest size which can be justified on economic grounds.

Important Help

An important help in this problem has been the Claus process for the partial combustion of hydrogen sulphide according to the equation:



Commercial application of this reaction in Europe dates back to the late 'twenties. In the Western hemisphere, the availability of cheap natural sulphur, coupled with the prevalence of natural gases of relatively low hydrogen sulphide content, has until the post-war years kept the expected returns from Claus plants below economically attractive level.

This picture in the Western hemisphere has during recent years been changed fundamentally on both counts. Demand for sulphur is now running substantially ahead of the productive capacity of the Texas sulphur fields and a system of allocations has recently had to be instituted by the producers. At the same time, important oil fields have been discovered, and others have only lately become economically attractive, in which the by-product gases are very high in hydrogen sulphide content. As a result of this changing situation, the last three years have seen the erection of at least six large Claus plants for the partial combustion of hydrogen sulphide to sulphur in the United States.

Apart from its obvious uses as a raw material for the production of sulphuric acid and as a commercial pesticide, the high-grade Claus sulphur is an 'on-site' raw material in the same location as large

amounts of methane. Thus, an ideal economic situation exists for the development and (since recent months) for the commercial application of the reaction between methane and sulphur to form carbon disulphide.

Two potential underlying reactions may be used for this synthesis:



Note that these equations indicate the existence of monatomic sulphur for the sake of greater convenience only. Actually, monatomic sulphur is almost non-existent at normal reaction conditions; until very high temperatures are attained, sulphur vapour is most prevalent in the molecular configurations S_2 , S_8 , and S_6 , where increasing temperatures favour the structures of decreasing molecular weight.

The More Favourable Reaction

At temperatures below 700°C ., reaction (2) is thermodynamically the more favourable; at higher temperatures, carbon disulphide can be formed in substantially quantitative conversion by either reaction. In actual practice, temperatures between 500 and 600°C . are chosen as an economic compromise.

In view of the high activation energy of $39,000$ cal/g-mole required for the predominant reaction (2), it is necessary to promote the synthesis catalytically. A number of catalysts have been investigated in this connection. Special importance attaches to the use of silica gel.

A recent investigation of optimum reaction conditions, due to Folkins *et al.*, has demonstrated the very great importance of space velocity, temperature, and sulphur/methane ratio on the yield of carbon disulphide in the presence of silica gel catalyst. Thus, at a space velocity of 500 , conversion rises precipitously from 30 per cent (of methane) at 500°C . to 90 per cent at 650°C . Similarly, at 550°C ., conversion can be raised from 55 per cent to 88 per cent by reducing the space velocity from 750 to 200 .

For satisfactory conversion in the economically operative range of reaction conditions, sulphur should be present in an excess of at least 100 per cent above stoichiometric requirements. For economic reasons, commercial conversion is most suitable at 70 to 80 per cent.

Of particular importance is the simplicity of the reaction system. Carbon disulphide is in effect the only reaction product (*i.e.*, in addition to the unavoidable formation of hydrogen and hydrogen sulphide accompanying reactions 2 and 3). There is no by-product present in sufficient quantities to necessitate purification of the carbon disulphide to reach commercial product standards. It is only necessary to remove unreacted sulphur from the effluent reactor gases before carbon disulphide is condensed. The non-condensable gases (methane, hydrogen sulphide, and hydrogen) are subjected to further processing in preparation for partial recycle. The condensed carbon disulphide itself is stabilised (mainly for the removal of hydrogen sulphide) in a simple evaporation step.

A number of methods are available for removing sulphur from the hot reaction gases. Particularly attractive is a system, taken over from Claus plant practice, which involves washing with liquid sulphur. In this operation, it is important to maintain the temperature between the melting point of sulphur and 160°C ., where the viscosity of liquid sulphur begins to rise to a level which creates almost insuperable handling problems.

Hydrogen sulphide is recovered from the gases by conventional alkaline absorption methods. It is possible to operate a Claus plant in conjunction with carbon disulphide manufacture, and thus regenerate sulphur from recovered hydrogen sulphide in accordance with equation (1).

A portion of the methane-hydrogen stream may be recycled to the reactor system in order to boost yields above the limited conversion obtained in each pass. The limit to the amount of recycle is set by the permissible degree of dilution which, in turn, is determined by the production requirements and the space velocity at which the plant is to be operated. A portion of the effluent methane-hydrogen stream must therefore be bled to fuel.

French Natural Gas Output Increased

Production of natural gas by the French Regie Autonome des Petroles last year amounted to 245 million cubic metres, an increase of 18 million cubic metres over 1949 . Some $22,359$ metres were drilled during exploratory work for new deposits.

Chemical Drying Problems

Material Handling Methods in the U.S.A.

by A SPECIAL CORRESPONDENT

REMOVAL of residual liquid from moist material plays an important part in many modern chemical processes. Drying may take place in different ways according to the nature of the material and the amount of moisture present, substances usually being divided into hygroscopic and non-hygroscopic.

Whatever the method employed, however, the problem of material handling not only during, but also after, the drying is generally recognised as a matter of increasing importance.

The following survey of some modern American methods is based on a paper by Mr. J. P. Wilson, development engineer, Messrs. Proctor and Schwartz Inc., of Philadelphia, manufacturers of chemical dryers, by whose permission the diagrams are reproduced.

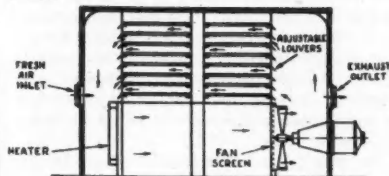


Fig. 1

One of the most widely used designs in batch drying of chemicals are tray dryers (Fig. 1). The usual sizes accommodate 16 to 20 trays, and a motor-driven fan blows hot air over the surface of the material. Adjustable louvers allow the rate of drying to be adapted to the quality of the goods. Loading and unloading of the trays can be

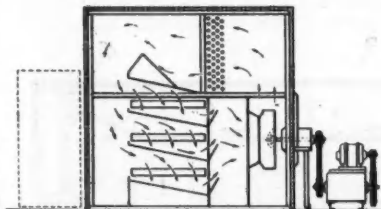


Fig. 2

facilitated by using lifting gear, or a roller conveyor to and from the drying cabinet.

Where a higher output is required, a 'through circulation' tray dryer type is recommended (Fig. 2). This machine is applicable only where physical characteristics of the material permit hot air to circulate through the bed on the tray.

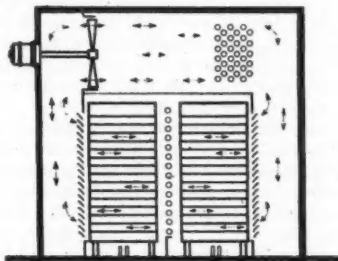


Fig. 3

Truck dryers use trays on trucks, which can be wheeled in or out from the compartment (Fig. 3). Output of this type of truck dryer is greater than of an ordinary tray dryer, but not as great as with continuous conveyor systems. Many mechanical handling problems turn up in the design of the trucks, but the most important factor is loading and unloading in practical operation. Hopper feeders, loading conveyor belts and other mechanical handling equipment can be used for filling the trays quickly and uniformly, because dryer efficiency partly depends on equal depth of the filling of each tray.

A further development of this batch type is the continuous tunnel truck dryer, where the trucks are continuously moved by means of conveyor chains through a tunnel, across which hot air is blown.

One of the most progressive methods of drying chemicals is the constantly moving conveyor dryer in various designs, all embracing some form of conveying which carries the material through drying chambers. Heated air is circulated freely during this passage through the bed of materials

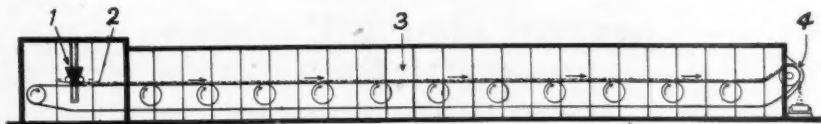


Fig. 4

on the conveyor. Either the shape and size of goods is adequate, or preforming can be applied. By using uniform sizes and shapes, each particle is subjected to a like amount of heated air, at rapid diffusion of moisture, but without surface hardening.

How this type of dryer solves continuous drying problems by means of conveyor systems is shown in the following examples.

Clay drying with large output recommends itself to the use of conveyor drying, if the clay is properly preformed and correctly fed (Fig. 4). Continuous dryers for large output were developed first in America, and later in other countries, which reformed the older methods used. In one typical installation of a Proctor individually designed continuous conveyor drying system, for use in drying clay, the following takes place: (1) Wet clay, with a moisture content of 42.1 per cent (Bone Dry Weight Basis) is delivered to the preforming feed of the dryer from a continuous filter. (2) Coming to the hopper of the rolling extruder feed, in this highly moist state, the material is forced through a perforated plate by rolls moving back and forth, and deposited on to the conveyor of the dryer in spaghetti-like extrusions. This particular preforming feed is ideally suited to the handling of clay, for the initial moisture content and the physical characteristics of this product are such that it will hold a definite shape after extrusion. (3) Loaded to a uniform depth on the moving conveyor, the clay is conveyed through the drying chambers, where heated air at 212°F. is circulated through the bed of material. By forming the clay into these small, uniform

shapes, more rapid diffusion is possible, which accounts for rapid drying and the uniformity of the finished clay. (4) After 32 minutes of drying time, the clay uniformly dried to a moisture content of 3.1 per cent (B.D.W.B.) is discharged from the dryer at the rate of 4,160 lb.—or more than two tons (Commercial Dry Weight) per hour.

Clay, thus dried, in the form of small particles, is uniformly dried all the way through to the centre of each particle. This makes possible rapid and complete dispersability in water and, therefore, makes the clay ideally suited to subsequent use.

Drying white lead to a uniform moisture content, on a large scale production basis, is made possible by the continuous conveyor system combined with a fin drum feed. In the installation illustrated (Fig. 5), the white lead is first mechanically dewatered by means of a continuous rotary filter, from which it is discharged into the hopper of the fin drum feed. In this hopper the paste-like substance is pressed into the grooved surface of the internally heated revolving fin drum, by pasting rolls.

On this drum, the material is dried sufficiently to be discharged to the conveyor of the dryer, in the form of small sticks of uniform thickness. It is then possible to circulate heated air through the bed of material on the conveyor, thus promoting rapid, uniform drying. By forming the material into small, uniform shapes, more rapid diffusion is possible, which accounts for the rapid drying and uniformity.

This process works as follows: (1) White lead is delivered from continuous filter to

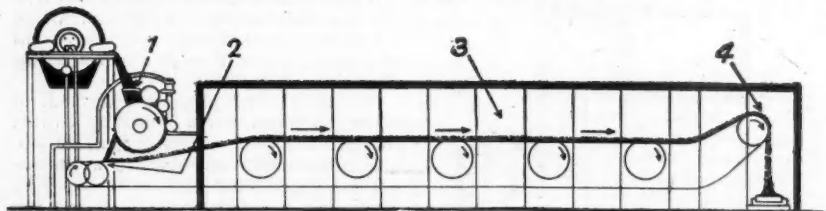


Fig. 5

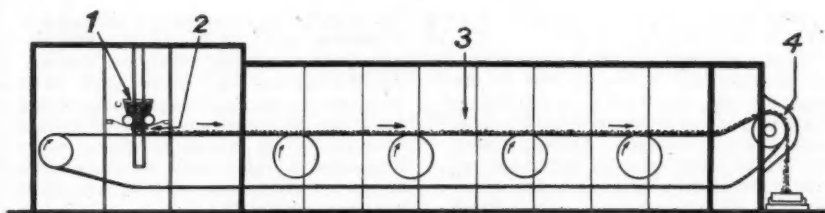


Fig. 6

hopper of fin drum feed of dryer with moisture content of approximately 69.3 per cent (B.D.W.B.). (2) Partially dried on fin drum, white lead is preformed into small sticks of uniform size and thickness and discharged to moving conveyor of the dryer. (3) Loaded on moving conveyor, the white lead is carried through the dryer. Temperatures are 250°F. at the beginning of the cycle and graded down to 190°F., at the end of the cycle. (4) White lead, uniformly dried, is discharged from dryer with moisture content of 0.075 per cent (B.D.W.B.) at the rate of 1,500 lb. (C.D.W.) per hour.

Drying of sulphur drugs is rather a delicate problem, but after prolonged research the following drying method (Fig. 6) has been evolved, which permits large output at great uniformity. A moving conveyor solves the mechanical handling problem through the hot air dryer. The process is: (1) Material is dewatered by means of a batch centrifuge and delivered to preforming feed of dryer. (2) Material is preformed into small extrusions by means of rolling extruder feed, equipped with a special grid type of extruder plate. This particular type of plate is ideally suited to preforming the stiff cake of material as it comes from the centrifuge. Extrusions enter dryer with a moisture content of 105.5 per cent (B.D.W.B.). (3) Material is loaded to uniform depth of 3.5 in. on moving conveyor. Circulation of heated air is through bed of material on moving conveyor, promoting

rapid uniform drying. (4) Material is dried to moisture content of 0.32 per cent (B.D.W.B.) at rate of 400-425 lb. (C.D.W.) per hour.

By using a continuous filter (Fig. 7), and preforming into fin drum sticks, a drying time of only 32 minutes has been achieved in drying 122 per cent moist calcium carbonate by means of a three-compartment dryer, as follows: (1) Calcium carbonate is delivered from continuous filter to hopper of fin drum feed of dryer with moisture content of approximately 110 per cent (B.D.W.B.). (2) Partially dried on fin drum feed, material is preformed, into small sticks of uniform size and thickness, and discharged to conveyor of dryer. (3) Loaded to a uniform depth on moving conveyor, material passes through 9-unit dryer. Temperatures begin at 270°F. in the first compartment, increases to 280°F. in second compartment and to 290°F. in third compartment. (4) Calcium carbonate, uniformly dried is discharged from dryer with moisture content of 0.25 per cent (B.D.W.B.) at the rate of 2,750 lb. (C.D.W.) per hour.

In all the above dryers special conveyors have been developed in order to allow heated air to be blown through the material. They must be either of perforated metal or woven wire construction. As it is impractical to make a conveyor in one piece that will satisfactorily travel around the ends of the machine without bending or breaking, short

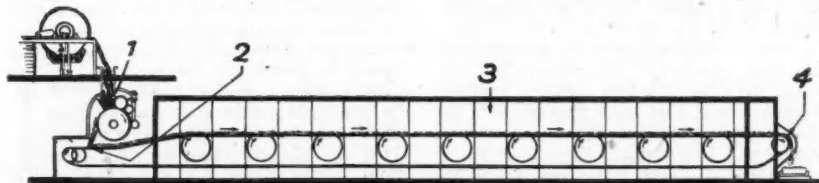


Fig. 7

sections are joined together to permit flexibility in continuous movement.

These joints must be sturdy, yet have to permit ample air to flow through so that material at the joints is not starved of hot air. A special method of hinged joints is applied to the above dryer types. Another remarkable feature is pressed metal guards fastened to each end of each section forming a travelling wall on both conveyor sides. Sturdy roller chains carry the conveyor through the dryer zones without strain.

As with all conveyor dryers, the rate of drying can be influenced by hot air temperature, relative humidity, air speed, direction of air movement, and the respective flow of material and hot air stream. Last, but not least, comes the speed of travelling of the material through the hot air dryer.

Variation of the conveyor speed is achieved by motor drive with variable speed transmission and gear reduction. These features are contained in an enclosure at the delivery end of each machine, and speed of travel can be instantly and accurately regulated by the plant operator.

Future Developments

Future developments are in the direction of controlling conveyor speed automatically from control impulses derived from moisture content of the material at the dry end. The main problem to be overcome is quick detection of the change of moisture content, and new moisture detecting elements are required for this purpose. These could be based on the change of an electric field with electronically magnified impulse, such as have recently been developed for webs of textiles.

Chemicals, powders and granular materials are frequently collected in pans, hoppers, bins and similar containers. Then they are conveyed to subsequent processing or to storage by trucks, belt conveyors, screw conveyors, or monorail systems. Air blast conveying is sometimes used for very light material, using a blower fan which blows the material from the dryer into storage bins.

Correctly designed and built handling and conveying equipment for dryers has, of course, been promoted by constant striving to lower labour, fuel and operating costs, to increase production and reduce space requirements. Important as these factors are for continuous drying, it has been found to be equally important to combine in one

operation the dryer's conveying and handling equipment with that of the preceding and subsequent operations. Each day engineers find it more and more important to study, understand, and even design, develop and build the equipment employed before and after the drying process to assure proper range control. This makes the design of the dryer conveying and handling equipment even more important.

Control requirements frequently complicate such design. The conveyor of course controls the time the product is in the drying chamber and thus directly bears on the allowable drying temperature reached. Along with time and temperature control there has been recently added moisture control.

This control will naturally add to the importance of properly designed conveyors. There is, for example, the new all-electric drive being widely accepted on warp slashing equipment, where an electric pick-up device indicating and recording the moisture content of the warp at the exit of the dryer also controls the conveyor and handling speed so as to give the correct warp moisture content.

The conveying system has undoubtedly become one of the main items of expense in dryer construction. This is markedly true where the conveyor must be constructed of a special metal such as aluminium, copper bearing metal, or stainless steel for a specific purpose, such as resistance to corrosion, cleanliness, protection against contamination of the product being handled, life span, strength and rigidity, and electric-current-carrying characteristics.

Efficient Conveyors Expensive

Electrical characteristics of conveyors brought to the engineer the first problems and troubles encountered in furnishing conveying means for (RF) radio frequency drying operations. An (RF) generator was needed to supply the proper characteristic field and some simple means for conveying the product through this field. The cost of the generating unit, transformers, lines, electrodes, and so on, dictated that the conveyor should be simple and cheap.

An efficient conveyor, however, could not be produced except at a cost as much or more than that of the generating equipment. This was brought about by rigid specifications on the conveying means to enable proper operations of the equipment.

Materials for Sulphuric Acid Production

Conversion of Indigenous Waste Products

THE critical shortage of raw materials for sulphuric acid manufacture is directing increased attention to the possibility of utilising Britain's own potential sources of sulphur. Scientific investigation has shown that the technical problems are not insuperable, the difficulties which have hitherto prevented commercial application of suitable recovery processes being mainly economic.

Coal burnt annually in Britain amounts to about 190 million tons per annum, its average sulphur content being 1.5 per cent. Calculations have shown that the total weight of sulphur discharged into the atmosphere each year is about 2.3 million tons, most of it being emitted as sulphur dioxide. If only a portion of this wasted material could be recovered the country's entire sulphur requirements would be assured.

For obvious reasons consideration could only be given to the recovery of sulphur from the emissions of very large coal consumers such as power stations or gas works. Some 800,000 tons of sulphur dioxide are emitted annually by electricity generating stations alone, so that the installation of successful recovery plants at major power stations could yield substantial quantities of sulphur. So far, however, no economic method for the recovery of sulphur from flue gas is in sight.

As far as is known, only two full-scale plants have been built in any country for the removal of sulphur compounds from flue gas, namely, those at the Battersea and Fulham power stations in the London area. In the process now used at Battersea the gas is scrubbed with river water to which a little chalk is added. The sulphur dioxide is absorbed by the water and neutralised by the alkali present as natural hardness and by the chalk. The calcium sulphite formed initially in solution is oxidised to a sulphate, which is discharged into the Thames.

Only One Proved

The only non-effluent process that has been proved on a full-scale plant is the Howden-L.C.I. process, which was used at Fulham before the war. In this process the gas is scrubbed by a suspension of lime or chalk in water, which is circulated through scrubbers. The calcium sulphate formed in

the process is a wet solid with no market value, which has to be dumped at sea.

No economic process for recovering elemental sulphur from flue gases has yet been developed, but in the form of ammonium-sulphate it can be recovered by the Fulham-Simon Carves ammonia process. This process was tested in a large pilot plant at the Fulham generating station before the war. It consists of scrubbing the flue gas with a concentrated solution containing ammonium sulphate, sulphite, bisulphite, thiosulphate, etc., to which ammonia in the form of concentrated gas liquor is added at a rate corresponding to the absorption of sulphur dioxide.

Filtrate Decomposes

To keep the concentrations constant, liquor is run off from the scrubber when necessary and replaced by water. The liquor so run off is filtered and then heated in an autoclave to 200°C. with the requisite small amount of sulphuric acid, when it decomposes to give ammonium sulphate and a little elemental sulphur.

Pilot plant trials were not entirely successful because it proved difficult to control the composition of the liquid in the scrubber, so that neither ammonia nor sulphur dioxide was lost with the scrubbed gas. A vapour pressure recorder has since been designed for this purpose, however, and has been successfully used to control a small pilot plant scrubber at the Fuel Research Station. The results obtained have been so promising that a plant capable of washing 25,000 cu. ft. of gas per hour and producing ammonium sulphate is now being installed. This plant will come into operation very shortly.

Assuming that large-scale recovery proves successful, the cost of production would be extremely high. The overall cost at present prices of the scrubbing process at Fulham is equivalent to the addition of 10s. to the cost of every ton of coal consumed in the boilers. It is considered probable that the net cost, after allowing for the value of the ammonium sulphate recovered, would be 9s. a ton.

On this basis production costs would amount to some £18 a ton, the present price of ammonium sulphate being about £10 a ton. Thus the market price would have to

appreciate by nearly 200 per cent before recovery from flue gases could be economically undertaken. In the light of current price trends this possibility cannot be entirely overlooked.

There are other considerations which might justify the recovery of sulphur dioxide by a process which would be discarded on purely economic grounds. By Act of Parliament it has been made compulsory for all new power stations built in Central London to wash their flues, while many local authorities elsewhere in the country are opposed to the establishment of power stations in their areas unless washing or scrubbing plant is installed.

Partial Recovery Possible

If new power stations in London or elsewhere are compelled to wash their flue gases, a portion of the cost might be recovered by producing ammonium sulphate instead of a useless by-product (calcium sulphate), which can only be discharged into a river or dumped at sea. There is thus a very strong case for adopting this process as standard practice at all new washeries, irrespective of market prices, and it is for this reason that the Fuel Research Station have been so interested in the problems involved.

Another source from which substantial quantities of sulphur might be recovered is unpurified coke oven gas. For use as town gas a purified product is, of course, required, but for many industrial applications coke oven gas is used without purification and its sulphur content is therefore wasted. Purification of coke oven gas would be a cheaper method of obtaining sulphur than the treatment of flue gases, but production costs would probably be some two-thirds higher than the present market price of sulphur.

Though both processes might conceivably become economic propositions if the price of sulphur continues to advance, it takes time to develop efficient processes and build commercial plants, so that neither of these potential sources are capable of immediate exploitation. Of greater short-term significance is the fact that plans have been made for recovering sulphur from oil refinery gases in all the new refineries under construction.

An outstanding feature of the present crisis is that it has not been caused by the scarcity of sulphur generally, but is due entirely to the shortage of this material in the form of little, yellow lumps which, except for small deposits in Sicily, are found in

significant quantities only in the United States. The manufacture of sulphuric acid from native sulphur has many advantages, since a relatively inexpensive plant for the production of sulphur dioxide is required. Because of the relative cheapness of this process most sulphuric acid plants established in Britain during the past ten or fifteen years have been designed for the treatment of native sulphur.

Having regard to the dollar situation and to the present United States policy of conserving its resources of this element for domestic requirements, the scarcity of native sulphur must be expected to persist. The opinion has therefore been expressed that, instead of embarking upon expensive schemes for augmenting sulphur supplies, it might be wiser to examine the possibility of converting our existing contact acid plants to burn pyrites, which is readily obtainable from Spain, Cyprus and other non-dollar areas. Pyrites requires a much more expensive and complicated plant for the production of sulphuric acid, but in view of its abundance it might be cheaper in the long run to switch over to this material. An additional inducement is afforded by the possibility of recovering large quantities of pyrites from British coal.

During the 1914-18 war quantities of lump coal-pyrites were used by the acid industry. This material was produced at several collieries by picking out large nodules of pyrites from the large-coal picking-belts. These nodules had to be hand-dressed free from adhering coal and shale. The sulphur content of the finished material varied from 38 to 42 per cent.

Gradual Decline

Between the two wars output gradually declined and in 1939 amounted only to some 4,000 to 5,000 tons per annum. At that period only three collieries were producing lump coal-pyrites, which was being used by three manufacturing companies. E. & A. West & Co., Ltd., of Derby, and the Basford Chemical Co., Ltd., used the material alone, while Imperial Chemical Industries (General Chemicals), Ltd., mixed it with imported pyrites.

Separation of pyrites during coal washing was demonstrated by the Fuel Research Station by experiments carried out in 1930-35. The product was recovered in the treatment of coal below $\frac{1}{2}$ in. size and contained about 40 per cent sulphur (dry basis). At

that time there seemed to be no possibility of marketing such a product in competition with imported pyrites containing 48 to 50 per cent sulphur. At about the same period the Rio Tinto Co., Ltd., one of the major producers of pyrites in Spain, was examining the possibilities of recovering coal pyrites in Britain, while encouraging results were also achieved in a pilot plant erected by Londonderry Collieries, Ltd., for the recovery of pyrites fines from dry-cleaner refuse at Seaham Collieries.

At the outbreak of the last war the possibility of being cut off from overseas sources of supply led to consideration of ways and means of utilising home-produced sulphur-bearing raw materials. As a result of representations made in December, 1939, the Ministry of Supply, through its Sulphuric Acid Control, decided to investigate the whole position. Mr. C. T. Hill, of the Rio Tinto Co., Ltd., and Dr. D. T. Davies, then principal scientific officer of the Fuel Research Station, were loaned to the Sulphuric Acid Control for this purpose, and the Fuel Research organisation placed the Coal Survey Officers at the disposal of the Ministry. Mr. Hill was recalled by his company in September, 1940, by which time much of the survey work had been completed.

The immediate object of the investigation was to find further supplies of lump, coal-pyrites and to explore the possibilities of installing concentration plants to recover 'fines' pyrites from colliery refuse. It was decided to attempt to make a product containing about 42 per cent sulphur and costing approximately 25s. to 30s. per ton at the recovery plant, this being the approximate c.i.f. value of imported sulphur (48 per cent sulphur) in 1938/39. The problems encountered and the results achieved have been reviewed by Dr. Davies.*

War-time Pyrites Production

During the 5½ years from July, 1940, to 30 September, 1945, the annual production of lump coal-pyrites was 44,389 tons, corresponding to an average of approximately 8,500 tons per annum with a peak production of nearly 9,500 tons in 1941. Throughout this period the total recovery of coal pyrites in the form of lump and fines amounted to over 115,000 tons. There was also an incidental recovery of approximately

140,000 tons of coal, most of which would normally have been dumped.

There were two main uses for the lump material, the first being for acid manufacture at plants equipped with hand-fired kilns, and the second for copper refining. Use of the lump material for acid manufacture was attended by many difficulties. Some crushing and screening were necessary before the lumps could be successfully handled, and there was also the effect of low sulphur content and high carbon content.

Sulphur Content

The sulphur varied between 38 and 42 per cent and the carbon content was about 10 to 12 per cent. This meant that the ore developed much more heat on roasting than the imported ore and the carbon also used some of the oxygen to form carbon dioxide, thus reducing the effective chamber space and the plant capacity. Price adjustments in relation to foreign ore had therefore to be made, the effect being that most acid manufacturers paid roughly 30s. per ton delivered for lump pyrites, compared with 60s. per ton delivered for imported material.

Only three of the fines plants came up to expectations. Nevertheless, production for the same 5½-year period averaged 22,155 tons annually and aggregated 72,122 net tons and 69,456 tons with an average sulphur content of 42.3 per cent (dry basis). The carbon content varied from about 4 to 9 per cent, being generally lowest in those plants which had shale in the form of dry-cleaner and washery refuse to deal with, and highest in those that had large proportions of 'brasses' in their feed material.

With one exception coal pyrites was used throughout in sulphuric acid chamber plants and mainly by acid manufacturers who required a low-arsenic material. In some of the chamber plants this material was used alone, but it presented a number of problems mainly concerned with carbon content. Many manufacturers therefore preferred to burn a mixture of coal pyrites with imported pyrites arranged to keep arsenic contents within limits.

For some time it was feared that the traces of many impurities that could be present in any product derived from coal would make it impossible to use coal pyrites on contact plants because of the danger of poisoning the catalyst. The experiment was successfully made, however. A blend with imported ore was used in which the coal

* 'Coal Pyrites,' by Dr. D. T. Davies, M.Eng., A.M.I.Mech.E., F.Inst.F., Journal of the Institute of Fuel, August 1948.

pyrites was gradually increased up to 75 per cent without any effect on the catalyst over many months of working.

Though the pyrites contained only 40 to 42 per cent of sulphur instead of the 48 per cent in the best classes of imported material, and provided less than 5 per cent of the acid trade's total requirements, it saved valuable shipping space at a critical period as well as foreign exchange. Since the coal pyrites was non-arsenical it was particularly valuable and its use avoided the necessity of turning some plants over to the use of brimstone imported from America. The cost of the plants as a whole was recovered by the end of 1946, the Ministry of Supply and the operating companies being considered as a single unit.

Plants Still Working

Most of the original eight plants are still working and the coal pyrites produced continues to be used by many acid manufacturers. It is reasonable to suppose that, from the experience gained, recovery of pyrites from British coal could be substantially increased.

Another valuable indigenous material worthy of consideration is anhydrite, a relatively pure form of calcium sulphate without any water of crystallisation which occurs in many parts of Britain. A plant to use this material was erected at Billingham in the early 1930's and has proved commercially successful, present production being in the vicinity of 100,000 tons per annum of 100 per cent sulphuric acid.

The raw material is mined in the vicinity of the factory at the rate of 2,400 tons a day and is used for the production of ammonium sulphate as well as sulphuric acid. Other deposits have been discovered in various parts of Britain. If necessary, the entire national requirements of ammonium sulphate could be produced from anhydrite.

Initial capital costs are high, but the use of anhydrite for sulphuric acid production yields a high quality cement clinker which is a valuable by-product. At Billingham the consumption of anhydrite is approximately 1.64 tons of acid produced, a ton of clinker being simultaneously obtained. The fuel consumption is 0.266 tons of coal per ton of acid.

Some manufacturers are producing ammonium sulphate from nitric acid, a process which could also be employed more exten-

sively to relieve the sulphur shortage. A successful method for producing superphosphate by treating rock phosphate with a mixture of nitric acid and sulphuric acid has been developed by the Chemical Research Laboratory, the proportion of nitric to sulphuric acid being about 4 to 3.

Reference may also be made to the survey of desert lakes in Libya which has been carried out by scientists from the Chemical Research Laboratory. These lakes are full of micro-organisms known as sulphate-reducing bacteria which reduce sulphates in sulphides. The rate of production of sulphide is low and to make the process economically feasible it would have to be speeded up by about 1,000 per cent. Investigators at the C.R.L. are examining strains of bacteria from various parts of the world to determine their speed of reduction, the influence of different environments, and methods of obtaining possible quick-reducing strains. From the results of this work it is possible that an industrial process might be worked out which could be developed on a commercial scale.

Examination of the potential sources of sulphur within the country reveals little prospect of achieving any immediate amelioration of the existing famine. On the other hand, it is evident that sufficient sulphur-bearing materials are available locally to render sulphuric acid and ammonium sulphate manufacturers independent of sulphur imported in any form.

In these unsettled times security has become more important than production costs. The little yellow lumps have, in fact, become a luxury which the country can no longer afford. The situation seems, therefore, to call for long-term measures involving the gradual conversion of the existing contact plants and increased utilisation of those indigenous materials which can most effectively be made available.

Economy Competition

The North British Rubber Co., Ltd., has announced a competition open to all employees asking for suggestions in the economical use of raw materials. High cost and scarcity of many chemicals, fabrics and other materials used in their programme have encouraged this move, which is additional to the normal suggestion prize scheme which the company operates.

Chemical Hazards and Explosions

Indicators to Dangerous Substances

IN a recent paper published in the *Journal of Chemical Education*, W. R. Tomlinson and L. F. Audrieth have drawn attention to the potential danger of certain classes of chemical substances. They claim that chemical explosions in laboratory or factory are avoidable, and for the most part arise through ignorance and carelessness; a knowledge of potentially dangerous chemicals and the observance of certain safety rules would help to eliminate unfortunate chemical explosions. The industrial chemist, who often employs unskilled labour in his factories and plants, must have an adequate knowledge of possible chemical hazards and be able to recognise possible sources of danger, if he is to be held responsible for the safety of his workers and factory. This point cannot be too highly emphasised in a chemical industry which makes such wide use of non-technical labour. An examination of certain classes of chemical materials may help towards this aim.

Firstly, the explosive properties of such single chemical compounds as nitroglycerine or TNT are well-known. They depend on two main factors, exothermic decomposition and oxygen balance. The former requires little explanation; when a compound contains elements which can easily undergo an exothermic rearrangement with the formation of very stable substances like CO_2 , H_2O and N_2 , the compound may prove to decompose explosively. This heat of decomposition to the most stable products can be evaluated for any material by a consideration of the heats of formation of the products and original material. Thermochemical data for most explosive materials have been tabulated in the literature.

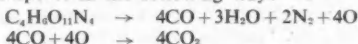
Useful Criterion

The concept of oxygen balance is not widely known and yet has proved a most useful criterion in determining explosive properties of chemical compounds. The oxygen balance is defined as the percentage excess or deficiency of oxygen required to oxidise completely all the carbon and hydrogen in any given compound to carbon dioxide and water. At or near an oxygen balance of zero, maximum explosive power is obtained. In computing the oxygen bal-

ance for possible explosive chemicals, hypothetical decomposition reactions leading to the formation of carbon monoxide, water and finally carbon dioxide are obtained by the ordered distribution of the oxygen present in the molecule to carbon and hydrogen. Nitrogen in such compounds is always assumed to form the molecular species—a contribution to the total energy of the decomposition which is most significant since free nitrogen atoms combine with the evolution of 171 kg.cals/mol.

Process of Decomposition

Thus, nitroisobutyl glycerol trinitrate decomposes in the following way:



No oxygen need be added or is in excess for the complete balancing of the equation. Hence the oxygen balance is zero. Ammonium nitrate, on the other hand, may be represented thus:—



One oxygen atom per ammonium nitrate molecule is in excess. Calculating on the relative weights, it is found that 16/80th or 20 per cent of the oxygen is in excess. The oxygen balance by definition is therefore +20. The values for some common explosives are listed below:—

Compound	Oxygen balance
Ammonium perchlorate	+27
Black powder	-22
Mercury fulminate	-17
Nitrocellulose	-24
Nitroglycerine	+3.5
Picric acid	-45
TNT	-74

Lotrop and Handrick (*Chemical Reviews*, 1949) have made some attempt to correlate the oxygen balance with the heats of decomposition of explosives. They have shown that the power of explosives is greater the smaller the oxygen balance. Most common explosives have small negative values. As a means of predicting possible explosive character the oxygen balance is a useful concept. Compounds containing oxygen in amount just sufficient to allow the formation of molecular N_2 , H_2O and CO_2 become immediately suspect as dangerous materials.

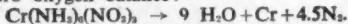
The preparation of oxygenated nitrogen-containing compounds would require the most careful conditions and the actual substances to be handled with special caution.

Explosions can often occur when two or more components are brought together in the proper proportions. The explosion results from the recombination of atoms in relatively weakly bound states to more stable states. If a rapid release of reaction energy is accompanied by large evolution of gases, grave explosions can occur. In this respect a mixture of an oxidant and reductant can be as dangerous as a single explosive compound, especially when the components are intimately mixed. The intimacy of contact assumes great importance in such potentially reactive systems.

Particle Size Important

The result of varying the particle size in a composition such as black powder can lead to a slow, 'pushing' explosive suitable for gentle blasting in coal or slate mines, or an energetic, brisant explosive useful in sporting cartridges. Simple inorganic mixtures are often prepared for teaching qualitative analysis; unfortunately, these can be particularly dangerous especially when elemental substances like phosphorus and sulphur, or powdered metals like magnesium or aluminium are incorporated with oxidising agents.

Often chemical substances possess structural or physical peculiarities with which a hazardous character can be associated. Of these compounds, one group which has escaped notice for many years comprises that of certain oxygenated metal imine complexes. These compounds, many of which are in everyday use in academic and industrial laboratories, are powerful explosives. Hexamine chromic nitrate is almost as powerful as T.N.T.; examination of its decomposition products shows it to approach zero oxygen balance:—



A list of these compounds can be found in *J. Amer. Chem. Soc.*, 1949, 375.

Analogous to the terms used to describe structural groups which confer or augment colour in organic molecules, Lothrop and Handrick have proposed the words 'plosophor' and 'auxoplor,' for groups conferring explosive properties. The 'plosophor' confers explosive character directly on the molecule while an auxoplosive group enhances the power of a substance which is

already explosive. Plosophoric groups, which lead either to explosives or very sensitive materials, include the following:— $-\text{O.N.O}_2$, $-\text{NHNO}_2$, $=\text{N.N.O}_2$, $-\text{NO}_2$, $-\text{NO}$, $-\text{N}=\text{N}-$, $-\text{O}-\text{O}-$, $-\text{N}_3$; while some auxoplorers are: $-\text{CN}$, $-\text{NOH}$, $-\text{O}-$.

The hazards attendant in certain chemical substances cannot be overstressed. Accidents on a major scale have occurred because of careless handling or insufficient knowledge of chemical materials, as in the Oppau disaster in 1923 in which something like 4,000 tons of ammonium nitrate exploded, killing over a thousand people and injuring many more. The nitrate pile was being used for fertiliser and often required the use of blasting explosives to break it up. Although this method had been employed for some considerable time with no disastrous effects, this one occasion caused the detonation of the whole pile. The temperamental nature of ammonium nitrate was apparent again in the recent Texas disaster, where a nitrate-laden vessel caught fire and exploded, and set a wave of explosions travelling through the vast refineries of Monsanto Chemicals, Ltd.

Respect Lacking

Often, potentially dangerous chemicals do not command the respect which is their due. This fact provides the chemical industry with its greatest hazard. The adequate recognition of the properties of such materials is of prime importance to industrialists if accidents and even disasters are to be avoided. An exceedingly interesting mixture used extensively in the U.S.A. as a nitrating agent, consists of liquid nitrogen tetroxide in hydrocarbon solvents. Such mixtures can be classed among the most powerful and sensitive explosives known. They approach complete oxygen balance and are completely miscible. Fuming nitric acid in certain solvents can lead to dangerous reactions. With aniline, it provides the mixture used in the jet-assisted take-off units; with methyl or ethyl alcohol it can produce an uncontrollable and often explosive reaction. Nitro-paraffins when treated with alkalis can lead to the formation of fulminic acid. Peroxides must all be classed as dangerous materials. This becomes significant when large quantities of ethers have to be distilled, yet accumulation of peroxides in the still residues can easily be avoided by washing with concentrated ferrous sulphate solution.

(continued at foot of next page)

Acute Resins Shortage

German Plastics Production Suffers

IN West Germany, as in most other countries of Western Europe, there is an acute shortage of thermoplastic resins or raw materials for plastics such as PVC (polyvinylchloride), polystyrol and other polymerisates. In Germany the principal manufacturers of PVC are the BASF (Badische Anilin & Sodafab) who continue to make the I.G. product, Igelit, the name under which it was formerly known; Chem. Werke Huls who manufacture PVC under the name of Vestolit; and Firma Dr. Alexander Wacker, under the name of Vinnol. Dr. W. Klein, in dealing with this matter (*Chem. Industrie*, 1951, 3 (3), 129-130), says that up to the time of the second World War Germany was the largest producer in this field. Until 1945 the chief centre for PVC was the Bunawerk Schkopau near Merseberg which had and still has a capacity of 40,000 tons per annum. But in West Germany the total capacity is no more than about 12,000 tons. A considerable expansion both in quantity and quality is hoped for. In the U.S.A. it is expected that PVC output will be raised to 300,000-500,000 tons in the not far distant future.

The hardening of the PVC is claimed as a purely German development, namely, the thermoplastic moulding, without addition of

softener, of sheets, tubes, rods, etc., forming valuable anti-corrosive materials for building and apparatus construction, especially in the food and allied industries. With softening agents PVC is now widely used as insulating and protective film and fabric for many different purposes.

With polystyrol also, U.S.A. production has increased to 100,000 tons or more, while the German limit under the Potsdam agreement is no more than 20,000 tons per annum, and actual production to-day is probably down to 7,500 tons, chiefly by Ludwigshafen and Huls factories. But a considerable expansion may be anticipated as soon as the necessary plant and machinery can be available. Among other things it was hoped that, in view of the Buna prohibition it might be possible to provide substitutes to some extent at least for Buna in some industries such as those engaged in the manufacture of linoleum, paints, water-proof paper, etc. A material consisting of 30 per cent butadiene and 70 per cent styrol was made in West Germany under the names: Lipolit, Duranit, and Emulsion 1073. But this too came under the prohibition ban of 20 October, 1949. The conclusion from Dr. Klein's brief review is that, despite the acute shortage of these synthetics in the world generally and especially in West Germany, the Germans are not allowed to use their existing plant to anything like its full capacity.

In a current advertisement the Badische Anilin & Sodafab, of Ludwigshafen, offer PVC marks R, G. L. K. etc., for different purposes: tubes, films, sheets, etc.

Chemical Hazards

continued from page 568

Mixtures of inorganic materials need careful preparation when there exists the possibility of constituent interaction. A molecular mixture of sodium nitrite and ammonium chloride can become a self-sustaining, gas-producing, highly exothermic reactive mass, merely by the application of a drop of dilute acid to one part of the mixture. In confined conditions, explosion will occur.

Explosions can be avoided. The dangerous reactions require energy for their initiation. This can be supplied by heat, light, electricity, impact or friction. Careful handling of unstable or sensitive materials is important; excessive application of energy from any source must be avoided. A true knowledge of the materials liable to explode, adequate fire prevention and cleanliness, can eliminate many of the hazards.

Cellulose Acetate Plant

PRODUCTION of high-grade cellulose acetate in this country has been the object for some time of Erinoid, Ltd., and James Nelson and it is now announced that a factory has been erected at Lancaster. The Hercules Powder Co., Ltd., London (a fully owned subsidiary of the Hercules Powder Company, Wilmington, Delaware, U.S.A.), has now become a partner in the enterprise.

The new factory is expected to begin operating in the second half of this year. Output will be absorbed by Nelson's Silk for rayon spinning; by Erinoid to replace acetate previously imported from North America for the manufacture of cellulose acetate moulding powders; and by the Hercules Powder Co., for sale as acetate flake.

Synthetic Resin Adhesives

Summer School at Cambridge

GOOD glueing depends not only upon good glues but also upon correct methods of using them. Specialised experience on the part of chemists, physicists and engineers is called for in the making of synthetic resin adhesives and a thorough knowledge of glueing technology is also required of technicians whose responsibility is to control their use. Only when the experience of the manufacturer is allied to the skill of the user can the advantages of modern adhesives be exploited with complete success.

These facts have prompted the organisation of a Summer School on the 'Technology of Synthetic Resin Adhesives' by Aero Research, Ltd., Duxford, Cambridge, to be held from 23-29 September.

The course is thought to be the first of its kind to be held in this country, and it is hoped that representatives will attend from the many and varied industries in which synthetic resin glues are, or could be, used.

Applications for enrolment have already been received from Belgium, France, Holland, Italy, the Scandinavian countries, Spain, Switzerland and many parts of the Empire.

Industrial Applications

The full five-day Course on Synthetic Resin Adhesives is designed to cover first their use in the woodworking industries, and second their application to engineering, electrical manufacturing and other industries. Alternative programmes will be arranged, but some lectures (for example, introductory talks on plastics, fundamentals of adhesion, methods of reducing setting times) will be common to both courses.

For students from the woodworking industries, emphasis will be upon urea-formaldehyde adhesives. Lectures will cover such aspects as storage life, spreading, assembly and pressing times, gap-filling properties, resistance to weathering, glueing problems, and accelerated 'curing.' The various requirements of plywood making, curved work, veneering, edge-joining, assembly glueing and laminating will be discussed in detail.

The alternative course will deal primarily with adhesives for metals and non-porous materials. It will include instruction on preparation of surfaces for bonding (for

example, pickling, degreasing), recommended joints, methods of testing, effects of surface treatments upon joint strength and electrical properties of adhesives.

Industrial uses of radio-frequency heating will be demonstrated in co-operation with Messrs. Pye, Ltd., Cambridge, and experts from outside the organisation will discuss subjects on which their specialised knowledge will be of value. Both courses will include a proportion of practical work.

Accommodation is being reserved at St. Catharine's College; lectures, practical work and demonstrations will be divided between Cambridge and the works at Duxford, nine miles to the south. By this means it is hoped to combine the amenities of a week's visit to the University town with the advantages of practical work in a modern factory.

New Synthetic Rubber

A NEW synthetic rubber, superior for certain uses to both natural rubber and other synthetic rubbers, has been developed by the U.S. Department of Agriculture. This new rubber, known as 'Lactoprene BN,' has outstanding resistance to dry heat, water, oils, below-zero temperatures, and ageing. It keeps its desirable physical properties at temperatures from 300° to about 30° below zero Fahrenheit. It is expected to excel natural rubber and other synthetic rubbers for such uses as oil seals in automobile transmissions, refrigerant seals, gaskets, and linings for fuel tanks.

Lactoprene BN was developed by scientists at the Department of Agriculture's Eastern Regional Research Laboratory in Philadelphia. It is similar to Lactoprene EV, a rubber with excellent high-temperature resistance previously developed by the laboratory and now in commercial production. The new product has greater resistance to low temperature and water than Lactoprene EV, as well as high resistance to heat and oils. The improved rubber is made from butyl acrylate and acrylonitrile, compounds which can be produced from agricultural materials (milk or corn sugars). The rubber's composition can be changed by varying the proportions of the two chemical ingredients. By this method, its swelling in oil can be modified without affecting its resistance to heat, a desirable advantage for uses involving exposure to oil.

Sulphur Recovery in Germany

Further Methods Used to Combat Shortage

THE Technical Information and Documents Unit (TIDU) of the Board of Trade, whose function it is to hold unpublished documents concerning ex-enemy industries, recently published a report on the various methods of recovering sulphur from hydrogen-sulphide-containing gases in Germany (see *CHEMICAL AGE*, 10 March, 1951). Inquiries resulting from that report have led them to believe that there might be considerable interest in an extension of that German sulphur-recovery survey if it was extended to cover the following recovery methods as well:—

1. The production of sulphuric acid by the Lurgi wet catalysis process.
2. The production of sulphur from spent oxide.
3. The recovery of sulphur dioxide and the production of sulphur from it.
4. Coal cleaning, processing of pyrites and the production of sulphur from pyrites and other minerals.
5. Purification of sulphur.
6. Pyrites and sulphur resources of Japan and Korea.

Regarding the separation of pyrites from coal-washeries in Germany, it is stated in F.D. 5558/47 that the building of additional plant in coal-washeries to deal with this problem created considerable difficulty in Germany. However, this question was under constant study there. In 1943, the Germans recovered 15,000 tons per year of pyrites from hard coal and an additional 20,000 tons per year of pyrites from brown coal. Ten plants had been installed in the Ruhr and about 50 per cent of the pyrites present was recovered as a product which met with the required specification, i.e., a sulphur content of 42 per cent. The Germans were hoping to increase considerably their recovery of pyrites from coal-washeries. It was also hoped that roasting plants might utilise low-grade pyrites containing only 30 per cent to 35 per cent sulphur. It should be pointed out that Section 4 of the bibliography does not include a complete list of references to coal-cleaning practice, but only those which relate to the possibility of reclaiming pyrites from the coal-washeries. The list, covering this section, includes a

recently acquired report on the use of xanthates of higher alcohols and other flotation chemicals manufactured in Germany at present (B/TP200/1946).

The production of elementary sulphur from pyrites was extensively studied in Germany and there exist several detailed reports on experiments with various tentative processes. None of these, however, were developed beyond a pilot-plant scale and it seems that they were considered to be uneconomic. From the material available to TIDU there appears to be no conclusive evidence that elementary sulphur was produced on a large scale from pyrites in Germany. One report, BIOS Final Report No. 1613, does mention, however, that a new process was said to have been developed by the Thyssen'sche Gas und Wasserwerk of Ham-born.

Burned in Steam and Oxygen

This process apparently involved burning the pyrites in steam and oxygen to give H_2S and SO_2 in correct proportion for their interaction to form sulphur. It was claimed that pyrites containing only 20 per cent of sulphur could be utilised. It is doubtful that this process was worked on a large scale, if at all. It probably related to a project for adapting the Thyssen-Galocsy producer (F.D. 1589/48) for the purpose of sulphur production from pyrites. Such a process would bear some resemblance to the Orkla process which is used in Norway, Spain and Portugal on a large scale. The latter process uses specially adapted blast furnaces for the purpose of recovery of sulphur from pyrites.

The sulphur obtained from pyrites contains a certain amount of arsenic from which it must be purified; this problem is dealt with under Section 5 of the bibliography.

The recovery of sulphur from spent oxide in Germany was carried out by the usual method of extracting with CS_2 . Where the tar content of the spent oxide was higher than 0.2 per cent the sulphur was subsequently purified with 20 per cent oleum (FIAT Final Report No. 994), or by extraction with methylene chloride (FIAT Report No. 1187, reel C-40, frame 7237).

An interesting item worth mentioning is

the successful pilot plant experiment for the production of very pure sulphur (99.8 per cent) from SO_2 by reducing with hydrogen (FDX. 657, frames 5596-608).

Two additional items of possible interest may be mentioned—the recovery of SO_2 from the manufacture of magnesium oxide by the reduction of MgSO_4 (BIOS Final Report No. 335), and experiments on the thermal decomposition of NiSO_4 (F.D. 4917/47). The former process was working on a plant scale producing 55 tons of sulphuric acid per day which was sold to the artificial silk industry.

Inquiries in connection with this report should be addressed to the TIDU, Lacon House, Theobalds Road, W.C.1, where the full bibliography may be seen and all documents and papers inspected by appointment.

Photo copies can be ordered at low cost.

The Sulphur Shortage

Questions Raised in Parliament

CONCERN in industry on the serious effects caused by the shortage of sulphur was reflected in the House of Commons last week by a number of questions put to the President of the Board of Trade.

Replying to Mr. M. C. Hollis and Mr. B. Janner about expected imports, Mr. Harold Wilson said that in spite of repeated pressure no reply had so far been received from the American Government about supplies for the second quarter of this year. The shortage of sulphur affected nearly every industry and he was fully aware of the widespread apprehension on this matter throughout the country. A supplementary quota of 19,000 tons of sulphur had, however, been granted to the U.K. by the United States Department of Commerce to cover the period until export allocations were notified.

In a further reply, the President stated that a cut of the order of 40 per cent would be inevitable if the allocation of 81,000 tons was not increased.

The possibility of substantially increasing the production of sulphuric acid in Germany and getting increased supplies from that country was raised by Mr. R. S. Hudson.

Everything possible was being done answered Mr. H. Wilson. Free importation of sulphur and sulphur products was allowed from wherever they could be found. It was a long job to get up the production of sulphuric acid, particularly in this country.

Asked by Mr. J. Harrison if there were any prospects of supplies of synthetic or manufactured sulphur to relieve this country from trespassing on U.S. supplies, Mr. H. Wilson replied that he was not aware of any. The use of anhydrites, pyrites, spent oxide, and other substitutes was being rapidly pushed ahead.

Was the Minister doing all he could to facilitate the importation of sulphur chemicals? asked Mr. G. B. Drayson. A certain quantity he understood was available from the Continent. The 33 per cent *ad valorem* duty made prices prohibitive. While the shortage continued and protection was not needed by the British manufacturers, would he not consult with them to see whether the duties could now be waived?

That was another question, answered the President. He understood, however, that some manufacturers had been buying sulphur and other products at prices four, five or six times the American price so that it did not seem that the duty would stand in the way of importation.

The possibility of getting sulphur from Iceland was being investigated, but it was understood that no immediate supplies were practicable.

Low-Grade Sulphur Recovery

A NEW refining process developed in the United States is expected to increase the nation's supplies of sulphur recovered from low-grade ore deposits. Most of the sulphur in the United States has been mined in an almost pure state. The new technique may be used wherever there are deposits of low-grade ore. The low-grade ore is sulphur mixed with rocks. After the ore is mined, it is ground into fine particles and then cooked with steam under pressure to force out the sulphur in fine granules. These are further purified by screening and flotation. This process produces 99.5 per cent pure sulphur.

The United States uses about 75 per cent of the sulphur it consumes to manufacture sulphuric acid. Substantial amounts of sulphur are recovered by American industry in the processing of copper, zinc, and lead ores. It is also extracted in the form of sulphuric acid from coal and sulphur-bearing gases. A major source of by-product sulphur is natural gas that contains hydrogen sulphide. This type is found in many oil fields.



The Chemist's Bookshelf

CHEMICAL ENGINEERING OPERATIONS. By Frank Rumford. Constable & Co., Ltd. London, 1951. Pp. 376. 30s.

The prospective author of an introduction to chemical engineering is faced with a serious dilemma. He can either give an exhaustive treatment of the underlying theory of the processes such as heat or mass transfer involved in plant practice, or else make a superficial study of the plants already constructed or projected available for carrying out the processes. In the first case he produces a forbidding textbook, which because of size, or in these days, paper limitations, cannot include much direct practical experience or 'know-how.' The student who would be deterred by such a book might easily read another constructed upon the second plan, but beyond learning the names of a number of plants, would gather little useful information. Dr. Rumford has steered a course, perhaps sometimes a little uneasily, between these two perils, and has produced a very readable, but at the same time extremely informative, textbook. He has, moreover, wisely conserved space by omitting operations not peculiar to chemical plant practice, such as electrical power transmission and refrigeration.

The chapter upon heat transfer although restricted is adequate in theoretical explanation, but the author has not included newer methods of heating, such as the use of high boiling thermostable liquids, or electrical heating with the easily controlled and increasingly popular heating mantles. The chapter on distillation was the most disappointing, and the reader was left with no very clear ideas upon the design and theory of fractionating columns. Another regrettable omission was that of chromatographic adsorption, a process which is being used to a considerable extent in pharmaceutical plants in the U.S.A. On the other hand the inclusion of a chapter on automatic controls was particularly welcome and instructive. The general treatment of the book is excellent and the facts have been arranged in a

very orderly manner. Each section has a number of illustrations and diagrams, and a number of worked examples are given to demonstrate the design of plants from first principles. Graphs are used frequently where applicable and there are a large number of references to original papers. It is suggested that the index should be improved and enlarged in later editions.—J.R.M.

SAFETY IN THE CHEMICAL LABORATORY:

H. A. J. Pieters and J. W. Creighton: Butterworths Scientific Publications: London, 1951. Pp. xii + 258. Figs. 50. 15s. By post 15s. 9d.

This book is the outcome of a collaboration between a chemist and a physician, and is both a valuable reminder of the hazards associated with the practice of chemistry and an excellent account of the methods of avoiding or minimising these hazards.

First discussing general hazards, the authors go on to deal with fire and explosion risks, gas cylinders and poisons—both those usually loosely referred to as 'chemicals,' and toxic gases and dusts. Next in order come protective devices and first aid, followed by a chapter on safety instructions and regulations. There is a section on analytical methods applied to toxic materials, and the book closes with a useful and varied collection of information in tabular form. Each chapter is supplemented by an extensive bibliography.

Considering how little specific instruction is normally given on the potential dangers of chemical work, it is probably surprising and certainly a matter for which one may be thankful that serious accidents are as rare as they are. Those responsible for laboratories, for whom the matter of safety must be a constant worry, should welcome this book. It should be read carefully by all those working with chemical processes, and certain parts of it should be thoroughly familiar to all persons occupied in the laboratory, whether they are actually engaged in chemical work or not.

In a book of this sort it is impossible to be completely comprehensive, and to include reference to everything which, at one time or another, has been a source of accident. Although the vast new source of hazard opened up by the increasing use of radioactive materials in chemical laboratories is practically untouched in the book, normal chemical work is very adequately covered. Each individual reader with any background of experience will have his own list of omissions. Thus the dangerous but regretably common practice of cleaning glassware by nitric acid-ethanol seems to receive no specific mention (though the *critical* reader might arrive at some conclusion regarding its risk from general statements here and there in the book). Again, the dubiously sound direction to destroy azides by acid is accompanied by no warning regarding either the explosion or the toxic hazards associated with the resultant hydrazoic acid.

However, these are details. No chemist or assistant chemist can read this book without becoming more alive to the day-to-day risks of his professional activities, and this is very much to be desired. As the preface emphasises, this is not a book for the library but for the laboratory bench. It should be the property, and the well-thumbed property, of every member of the laboratory staff.—C.L.W.

GLASS: A HANDBOOK FOR STUDENTS AND TECHNICIANS. Edited by J. Home Dickson. Hutchinson, London, etc., 1951. Pp. 200. 25s.

Old-established industries have a strong tendency to be empirical industries, and when one has been established over 4,000 years it might well be excused for showing some lack of flexibility. Yet the glass industry, with its scientists and technologists, has maintained a spirit of perpetual youth in its ever-fresh approach to its problems. This is all the more remarkable when one considers the heavy capital expenditure involved in large-scale glass making. In chemical composition, technical devices, artistic designs, furnace design and operation, as well as in wider application of automatic machinery, this industry has usually shown itself responsive to the latest possibilities.

These facts are well brought out in this handbook for which the editor makes a modest claim that is very adequately ful-

filled. His aim has been to give an overall picture of the structure, composition, manufacture and applications of glass. The treatment is in fact extensive but not deep, general and not too detailed or advanced. It is a symposium to which, in all, eight authors have contributed, although the editing has been very successful in smoothing out any possible original unevenness in style.

The opening section of five chapters on general principles is likely to be the most interesting to the chemist. It discusses the special character of this supercooled liquid, urging the adoption of the description 'the vitreous condition' to describe its pseudo-solid physical state. Other chapters discuss the chemistry of glass and its physical properties, while optical glass has a complete chapter to itself. This section includes a satisfactory brief, elementary treatment of the solid physics of glass, and a similar discussion of the chemical physics culminating in a re-statement of Zachariasen's empirical rules for deciding whether a given oxide could form a glass. Adequate references are given and the editor is well justified in stating that the book contains sufficient information to form a sound basis for further investigation by the interested student.

Further sections of the book deal with the manufacture and applications of glass. A chapter on chemical glassware will help the general chemist to appreciate the special problems of his colleague in this industry. Unfortunately the section on glass chemical plant is very brief and very general. Although the usual reassurances on freedom from breakage are repeated no operational or cost data are quoted. One gets the impression that in fact they might not stand the ordeal of publication and examination, because this seems to be a general defect of papers on this subject. Yet one must appreciate the undoubted advantages of the use of glass for small plant-scale production, particularly for valuable pharmaceuticals.

This book is a good production, clearly printed on good-quality paper which therefore also reproduces the illustrations faithfully and well. The latter are often of artistic merit too. Diagrams are clearly drawn and captioned.

While the advanced worker is not likely to gain anything from this work, it can certainly be confidently recommended to its intended readers—students and technicians.—J.B.

OVERSEAS

Dutch Superphosphate Expansion

Owing to lessened imports of sulphuric acid from Belgium, the Albatros company of Utrecht, which already produces about half of Holland's total output of superphosphate, is planning to increase manufacture of this acid, for pyrites from abroad form most of the raw material. Production of superphosphate has also been begun at Pernis. An appeal has been made to the Amsterdam capital market for a fresh issue of shares to finance these projects.

New U.S. Uranium Refinery

A project to build a \$30,000,000 uranium ore refinery and other facilities to produce uranium 'feed' material on a 1,200-acre site near Cincinnati, Ohio, has been announced by the U.S. Atomic Energy Commission. The new plant will dry, crush and weigh uranium ore and convert it into brown oxide. The material will then be changed to green salt (UF₄) and transported to Oak Ridge, Tennessee, and other atomic plants. A staff of approximately 1,200 will be employed when the refinery is in operation.

Chemically Treated Trees

Injecting certain chemicals into living trees to 'inoculate' them against insects and consequent decay can provide the mining industry with a new source of low-cost treated timbers, according to the U.S. Bureau of Mines. Tests were made in a California forest laboratory by the Department of Agriculture between 1937 and 1950. Chemicals were injected in solution into the sapstream of green trees at the base and carried to the foliage through the sapwood without entering the heartwood or the bark. Timbers treated this way, it is claimed, can be used without removing the bark or having to wait for the wood to season.

New Canadian Chlorine Plant

The first sizeable chlorine plant in the United States or Canada to use De Nora mercury-type cells is to be erected in Ontario for Marathon Paper Mills of Canada, Ltd. The plant, designed by Monsanto, will be constructed by the Leonard Construction Co., of Chicago. Production capacity will be 25

tons of chlorine a day and the plant will manufacture rayon-grade caustic soda, chlorine, electrolytic sodium hypochlorite and synthetic hydrochloric acid. Construction is possible due to a tentative agreement between Dr. Oronzio De Nora, head of an Italian company and Monsanto for the use and sale of the mercury cell in the U.S.A.

'Fuel-less Engine' Claim in Australia

Engineering interest has been aroused in Australia by an announcement of the invention of a fuel-less engine in Queensland. The inventor claims that it is based upon certain principles of relativity, discovered during research into energisation of matter. He states that he has translated the principles into practical mechanics through 'the harnessing of atomic potential through a catalyst, minus fission.' It is also claimed that the problem of atomic radiation has been successfully overcome. Considerable secrecy is being maintained about the engine which is being investigated by the Department of Air.

Latex Foam in Australia

Latex foam, a rubber powder which is capable of raising the melting point of bitumen, will soon be industrially available in Australia. The British Rubber Development Board, which is associated with research institutes in Malaya and Great Britain, has opened an office in Melbourne for marketing purposes. The Board is financed by a levy of 9d. on every 100 lb. of rubber produced, imposed by the Malayan Government.

Australian Bauxite Reserves

Bauxite reserves of the Australian Aluminium Commission now stand at 8,600,000 tons. The commission is at present negotiating with overseas interests for the purchase, at suitable delivery dates, of high-grade Malayan ores, the use of which is planned for initial ingot production. A large quantity of fabricated steel work has been purchased from Norway for aluminium factory buildings to be erected at Bell Bay in Tasmania. Local consumption of aluminium in all its forms in Australia is estimated between 13,000 and 14,000 tons per annum.

HOME

Oil Company's Name Change

The Anglo-American Oil Co., Ltd., announce that the name of the company has been changed to Esso Petroleum Co., Ltd. This step has been taken to give fuller recognition to the close association which has developed in the public's mind between the name of the company and its well-known Esso products and trade mark. It also brings the company into line with affiliates throughout the world of the Esso organisation. Since its foundation in 1888, the company has been one of the pioneers in the oil trade in the United Kingdom, and has made many significant contributions to the industry's progress. The new Esso refinery—the largest in Europe—at present being built at Fawley, near Southampton, will be in operation later this year.

Worsening Predicted

Addressing a Press conference of the East and West Ridings Regional Board of Industry in Leeds, Mr. A. Dawes Robinson, Regional Controller of the Board of Trade, predicted a worsening of the position in Yorkshire industry as time went on because of the shortages of raw material in industry to-day. He felt it might lead quickly to unemployment. He was referring chiefly to the shortages of sulphur and base metals. He said: 'Quite frankly I do not know how industry has kept going. But if we get more help along sulphur lines the position will change for the better.'

KID Exemptions

The following chemicals have been exempted from Key Industry Duty for the period to 19 August, 1951:—Carbon disulphide, cobalt sulphate; formic acid (strength less than 98 per cent by weight); lithium carbonate; phosphoric acid; tricresyl phosphate (a hydroxybenzene ester homologue); triethyl phosphate (an ethyl ester). The Order is the Safeguarding of Industries (Exemption) (No. 2) Order, 1951, and is published as Statutory Instruments, No. 445.

BAC Visit to Cambridge

A conducted visit to the Cambridge colleges arranged in co-operation with the University Chemical Society is announced by the London Section of the British Associa-

tion of Chemists for Sunday, 27 May. Non-members are invited to participate. Full particulars may be obtained from the hon. secretary, Mr. H. Warson.

Sulphuric Acid Price Increase

The Board of Trade announces that the maximum price of weak sulphuric acid (77 per cent H_2SO_4) is increased by 27s. 6d. per ton (NOR 26s. 6d. as was announced on 4 April). The increase became operative on 9 April at the same time as the extra 33s. 9d. per ton on strong acid already announced.

Dunlop Donations

Dunlop have sent donations of 50 guineas to the National College of Rubber Technology; 100 guineas to the British Travel and Holidays Association; 150 guineas to the Trade Marks, Patents and Designs Federation; £200 to the Industrial Management Research Association; £200 to the Industrial Welfare Society; and £250 to the Royal Institute of International Affairs.

Calcium Carbide Prices Raised

Rising costs of production are said to be the cause of the increased prices for calcium carbide, sold through the Carbide Distributing Agency, Ltd., announced by the Board of Trade as becoming effective from 2 April.

As from the same date, prices for calcium carbide sold from merchants' warehouses, are on an ex merchants' warehouse basis and carriage charges to destination will be the responsibility of the user, and not the Board of Trade.

Revised prices per ton of 2,200 lb., packed in 220 lb. drums will be as follows:—

A. Sales delivered in one consignment from factory direct to users. Lots of 4 tons and over, grade 15/25 mm. to 50/80 mm. £29 17s. 9d.; 8/15 mm. £1 less; 2/4 mm. to 4/7 mm. £2 less. Other lots increased accordingly.

B. Sales delivered in one consignment to users from merchants' warehouses. Lots of 4 tons and over, grade 15/25 mm. to 50/8 mm. £30 10s. 9d.; 8/15 mm. £1 less; 2/4 to 4/7 mm. £2 less. Other lots increased accordingly.

Calcium carbide packed in 100 lb. or 110 lb. drums will be charged for additionally at the rate of £1 per ton on all prices.

• PERSONAL •

Mr. A. B. HITCH, A.M.I.Mech.E., has been appointed to the staff of Brookhirst-Igranic (S.A.) Pty., Ltd., the newly-formed company which will promote the interests of Brookhirst Switchgear, Ltd., and the Igranic Electric Co., Ltd., in South Africa. Mr. Hitch, who had been at the Brookhirst London office for several years, left for Johannesburg early this month.

The annual general meeting of the Nutrition Panel of the Food Group of the Society of Chemical Industry will be held at Burlington House, London, on 9 May. The following officers have been appointed by the Food Group committee for 1951-1952: Dr. J. I. M. JONES, chairman; Mr. L. C. DUTTON, hon. secretary; Dr. W. F. J. CUTHBERTSON, member. Nominations are requested for the two members elected annually.

SIR JOHN SIMONSEN, director of the Colonial Products Research Council, will be among the seven recipients of honorary degrees at Birmingham University on 30 June. Sir John, whose investigations into the essential oils are well-known, was the first recipient in 1949 of the Fritzche Award presented by the American Chemical Society to encourage such research.

Mr. H. HAYGARTH JACKSON, a director of the Bleachers' Association and an executive member of the Cotton Board, was recently decorated with the cross of Chevalier of the Legion of Honour by the French Consul, Monsieur B. A. Durner, at a private ceremony in Manchester.

At the annual meeting of the Liverpool and North Western Section of the Royal Institute of Chemistry at Liverpool University, on 5 April, PROFESSOR T. P. HILDITCH, who presided, mentioned that the section now had 1,000 members and 500 students. During the year a sub-section had been formed at Preston. Mr. B. D. W. LUFF's nomination by the committee as chairman, to succeed Professor Hilditch, was confirmed. DR. F. J. SMITH (head of the chemical department of the Liverpool College of Technology) is the new vice-chairman. MR. LUFF and MR. J.

ASHLEY JONES are to continue in office as hon. treasurer and hon. secretary, respectively. MR. NEIL HERON (Deputy Liverpool City Analyst) was appointed hon. assistant secretary.

The Gold Medal of the Society of Dyers and Colourists was last week presented by the president, Mr. F. SCHOLEFIELD, to Mr. HAROLD FOSTER in recognition of his work for the society and his 14 years as secretary of the West Riding Section.

MR. RICHARD F. SUMMERS, chairman of John Summers & Sons, Ltd., has been appointed a director of the Royal Insurance and the Liverpool and London and Globe Insurance Companies.

DR. MANSON BENEDICT has been appointed professor of chemical engineering at the Massachusetts Institute of Technology and will take up his post on 1 July. From 1938-1942 the doctor worked with the M. W. Kellogg Company and developed a widely used equation of state for hydrocarbon mixtures. During the next four years he was associated with the Kellogg Corporation, and was in charge of the process design of the gaseous diffusion plant for the concentration of uranium-235, which was built for the Manhattan project at Oak Ridge, Tenn. In 1946 he was chairman of the technical committee on the Control of Atomic Energy of the War Department. Dr. Benedict is the author of numerous scientific papers on hydrocarbon thermodynamics, separation processes, and physico-chemical measurements.

Lustrex in Australia

First production of Lustrex in Australia is announced to be shortly at the Melbourne factory of Monsanto Chemicals (Australia), Ltd. Use of the product in Australia has been limited until now as the only sources of supply have been Canada and the U.S.A. With the starting of the Melbourne plant and production by Monsanto Chemicals, Ltd., at Newport in England, there should be a sufficient quantity of this polystyrene to satisfy all Australia's needs.

The Stock & Chemical Markets

NOW Budget uncertainties have been removed, buyers are generally expected to return to markets, although demand will probably be selective. Many industrial shares are still on an attractive yield basis on last year's dividends, and in many cases there would have to be a heavy fall in earnings to necessitate reduced dividends.

Apart from shortages of essential materials, rising costs are likely to present growing problems for industry necessitating raising additional capital. Moreover it will be difficult to do this in the form of ordinary shares unless shareholders can be assured that there are good prospects of future earnings being maintained.

Owing to the probability that there will be a trend to higher money rates, fixed-interest securities of all kinds will probably show a movement to lower market values over the next twelve months; while ordinary shares of industrial companies may appreciate in price. With the value of existing plant and machinery rising, it is only logical that industrial ordinary shares should also move higher even if dividends are unchanged at last year's levels.

Chemical and kindred shares have attracted rather more attention, partly because of renewed hopes that the U.S. may make larger sulphur supplies available, and partly because of wider recognition that most chemical shares show yields which compare favourably with the return on other groups of industrial shares.

Imperial Chemical at 46s. 3d. have not held best levels, Fisons have been firmer at 27s. 3d., and British Glues 4s. units rallied further to 22s. 6d. Shares of plastic companies were more active. British Xylonite were up to 83s. 9d., British Industrial Plastics 2s. shares 7s., Klemann 11s., while Erinoid were up to 10s. 3d. following news of the company's latest developments. De La Rue moved higher at 26s. 9d.

The 2s. shares of Major & Co. were active up to 4s., while Brotherton 10s. shares were up to 23s. because of expectations of good financial results and the scope for higher earnings this year owing to the rise in the price of sulphuric acid. Laporte Chemicals 5s. units rallied to 10s. 7½d. British Aluminium at 43s. have been steady on the full report and accounts, and British Oxygen at

93s. remained under the influence of the past year's profit figures.

Staveley have been good at 89s. 1½d. on nationalisation compensation estimates. Glaxo Laboratories eased slightly to 62s. 9d. although the market continues to expect that when more capital is required it will be in the form of an offer of additional ordinary shares to shareholders. Oils moved narrowly, but Anglo-Iranian strengthened a little on news of Anglo-U.S. talks on the oil developments in Persia.

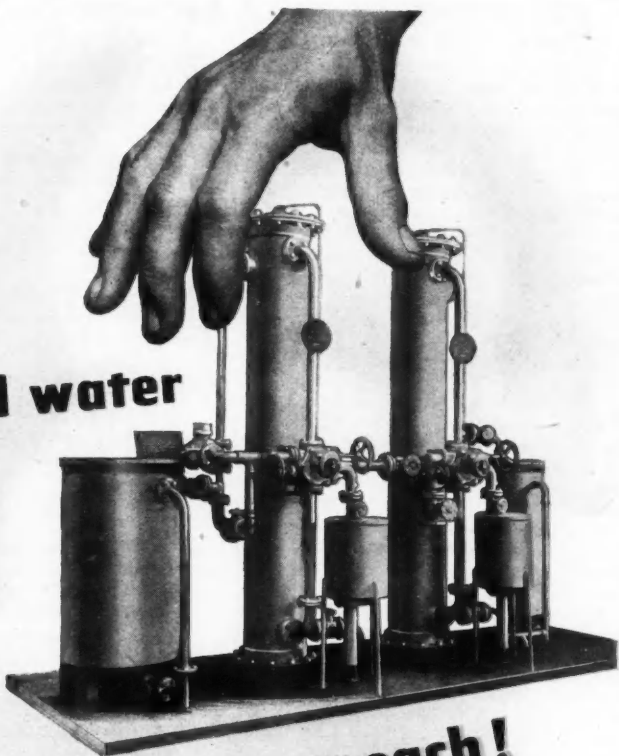
Market Reports

LONDON.—All sections of the industrial chemicals market have experienced steady trade conditions with a good volume of inquiry both from home buyers and overseas. Although the implications of the sulphur shortage continue to be a serious factor the main topic of interest has been a jump in the price of industrial alcohol and its effect on solvents and other products. Price adjustments received too late for our previous report include a rise of 50s. per cwt. in the price of glycerine, £7 per ton in the price of lithopone and 26s. 6d. per ton on sulphuric acid BOV, the last operating as from 9 April. As with most other sections, the coal-tar products market is firm, with few offers available for spot or nearby delivery.

MANCHESTER.—The shortage of sulphur and sulphuric acid is having its effect on operations in some of the Lancashire consuming outlets and others are likely to be severely hit during the coming months unless there is an appreciable improvement. In the meantime, there is a brisk demand for pretty well all descriptions of heavy chemicals on the Manchester market and the past week has witnessed a steady flow of delivery specifications for the alkalis and most other lines on the home market, with fairly active conditions reported in respect of overseas business. In the tar products section there are plenty of inquiries about for both light and heavy materials and producers generally are well sold forward.

GLASGOW.—The Scottish heavy chemical market remains steady, although many chemicals are in seriously short supply. The export market continues to deteriorate owing to very heavy home demands.

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Company News

Bradford Dyers' Association, Ltd.

A great deal of work had been into research on unshrinkable and stabilised finished in both synthetic and natural fibres stated the chairman, Mr. J. Ewing, in his report to the 53rd annual general meeting of the Bradford Dyers' Association, Ltd., held on 4 April. Shortage of raw materials, particularly sulphur, was creating a precarious situation with difficult problems, for substitution in many cases was not feasible. Gross trading profits were a record with a total of £2,836,523, an increase of £1,063,280 on the previous year. Dividend of 10 per cent recommended on ordinary stock, the largest since 1928.

Anchor Chemical Co., Ltd.

The raw material problem, particularly the shortage of sulphur, was referred to by M. T. H. Hewlett, F.I.R.I., chairman of the Anchor Chemical Co., Ltd., in his statement on the year ended 30 November, 1950, presented at the 44th annual general meeting held in Manchester on 22 March. Mention was also made of the production of certain grades of carbon black in the U.K., though it was not yet possible to state what effect this would have on the imports from the U.S.A. of the company's subsidiary, The United Oil and National Gas Products Corporation, Ltd. Trading profit was £103,496. A final dividend of 18½ per cent on the ordinary shares, was recommended, making a total for the year of 25 per cent.

New Registrations

Jenograph, Ltd.

Private company. (493,747). Capital £1,000. Manufacturers and producers of and wholesale and retail dealers in chemicals and chemical preparations, including rust removing and rust preventing processes, etc. Directors: J. H. Lawrence, and R. Lawrence. Reg. office: Gloucester House, 19 Charing Cross Road, W.C.2.

Sheringham Chemicals, Ltd.

Private company. (493,899). Capital £3,000. Manufacturers of agents for and dealers in chemicals, etc. Directors: A. Goldfinger, and N. Geller. Reg. office: 17 Station Road, Swinton, Lancs.

Next Week's Events

TUESDAY 17 APRIL

Society of Chemical Industry

London: Manson House, 26 Portland Place, W.1, 6.30 p.m. E. M. Evans: 'Cashew Nut Shell Liquid and its Applications.'

Purchasing Officers' Association

Nottingham: Boots Staff Training Dept., Station Street, 6.30 p.m. Talk and film on 'Glass.'

Liverpool: Exchange Hotel, Tithebarn Street, 7.30 p.m. W. Holland-Bowyer: 'Rubber and its Applications to Industry.'

Cardiff: Temple of Peace and Health, 7.30 p.m. A. S. Wylde: 'Plastics.'

WEDNESDAY 18 APRIL

British Association of Chemists

London: The Kent Room, Caxton Hall, Victoria Street, S.W.1, 6.45 p.m. Symposium: 'Technical Service: An Expanding Branch of Applied Chemistry.' Speakers: R. J. Smith, R. C. Tarring and C. W. Tod.

Society of Chemical Industry

London: Burlington House, Piccadilly, W.1, 6.0 p.m. Last Annual General Meeting of the Microbiological Panel.

London: Burlington House, Piccadilly, W.1, 6.15 p.m. Paper presented by Dr. R. G. Tomkins: 'Microbiological Problems in the Preservation of Fruit and Vegetables.'

The Textile Institute

Manchester: Town Hall, 2.30 p.m. Annual Meeting, 3.30 p.m. Mather Lecture given by Dr. J. C. Withers.

THURSDAY 19 APRIL

The Royal Society

London: Burlington House, Piccadilly, W.1, 10.30 a.m. F. P. Bowden: Discussion on 'Friction.'

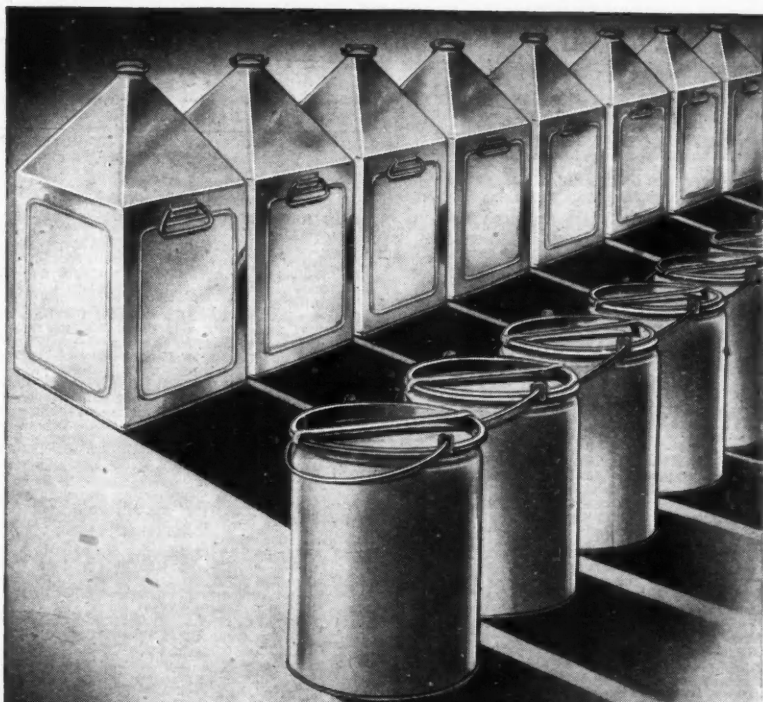
FRIDAY 20 APRIL

Society of Public Analysts

Edinburgh: North British Hotel. G. Rathay: 'The Microscope as an Analytical Aid.'

Fine Chemicals Group (SCI)

London: King's College, Strand, W.C.2, 7 p.m. Annual General Meeting. 7.30 p.m. Dr. J. G. Fife: 'The Patents Act, 1949, in Relation to the Fine Chemicals Industry.'



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27th.

ASSOCIATE MEMBERSHIP EXAMINATION

APPPLICATION forms (returnable 1st Jun^o 1951) and particulars of the 27th Associate Membership Examination may be obtained from the Hon. Registrar, INSTITUTION OF CHEMICAL ENGINEERS, 55, VICTORIA STREET, WESTMINSTER, LONDON, S.W.1. **NOTE.**—Written and oral Examinations will be held in September, 1951. Home Papers will be issued in January, 1952.

SITUATIONS VACANT

CHEMIST aged 22-35 required of B.Sc. or A.R.I.C. standard for Organic Chemical Works near Birmingham. The duties include investigations on work processes and are varied and interesting. Applicants should possess initiative and persistence. A Contributory Pensions Scheme is in operation. Apply Box No. C.A. 3007, THE CHEMICAL AGE, 154, Fleet Street, London, E.C.4.

LONDON firm of shippers and exporters desirous of expanding their activities seek a gentleman with connections to the chemical and pharmaceutical trade both in this country and overseas, to take charge of their chemical section. Remuneration depending on experience and qualifications to be fixed by mutual agreement. Interview by appointment. Please write: The Secretary, Messrs. G. H. Wilkins & Co., Ltd., 18/19, Ironmonger Lane, Cheapside, E.C.2.

PHYSICAL CHEMIST—A graduate, age about 30 preferably with a higher degree and industrial experience, is required by J. & G. Cox Limited, Glue & Gelatine Manufacturers. The individual appointed will be expected to master the technical details of manufacture, and the scientific controls used in the industry. He will understudy the Technical Director, and there will be opportunities for research. Commencing salary will depend on age and experience, but will be in the range £700-£950. Applications should be sent to the Technical Director, J. & G. Cox Limited, Gorgie Mills, Edinburgh, 11.

RESEARCH AND DEVELOPMENT CHEMIST/TECHNOLOGIST required for new specialised and interesting process in Rubber Factory near London. Applicants should possess B.Sc., A.I.R.I. or A.I.R.C. qualification. They must be of British Nationality and not above 27 years of age. Experience in Rubber Technology an advantage. Salary according to age, qualifications and experience. Particulars to Box No. C.A. 3009, THE CHEMICAL AGE, 154, Fleet Street, London, E.C.4.

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Two steam jacketed **ROTARY VACUUM DRYERS**, each 17 ft. 3 in. by 4 ft. 6 in. diam. Manhole in barrel with cover. Mounted on roller tracks and driven through glanded trunnion bearings. Discharge through S.J. chamber.

Horizontal TROUGH MIXER DRYER by R. Simon. Internal dimensions, 8 ft. long 2 ft. 6 in. deep by 2 ft. 8 in. wide. Agitator is bank 16 solid drawn tubes, 6 ft. 6 in. long by 2½ in. o.d. Tubes tested to 150 lb. sq. in. Chain and sprocket drive. 8 in. square bottom side discharge.

TWIN ROLL DRYER by Simon. Steam-heated rolls 5 ft. by 4 ft. diam. Roll pressure, 80 lb. sq. in. Complete with galvanised worm discharge conveyors, and hood. Vee-belt driven from 15 h.p. Higgs motor, 400/3/50, 730 r.p.m. through reduction gear.

TWIN ROLL DRYER by Simon. Steam-heated rolls, pressure 80 lb. sq. in., 5 ft. by 4 ft. diam. With galvanised worm discharge conveyors and hood. Vee-belt driven by 15 h.p. geared motor by Higgs, 400/3/50. Speed 1,420/101 r.p.m.

DRYING INSTALLATION by Manlove-Allott of Nottingham, comprising **ROTARY DRYER** 60 ft. long by 8 ft. diam., of ½ in. plate, 2 roller paths, drive on to main girth gear through open reduction gear. Bennis unit patent travelling grate stoker, 43½ sq. ft., grate area for furnace at feed end, also Dust Extraction Plant by Sturtevant, comprising 32-in. steel-cased fan and two 11 ft. diam. cyclone dust collectors.

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Size No. 3 Junior Hammamack HAMMER MILL with fan and cyclone, also No. 1 size **Miracle GRINDING MILLS** and one size **3W Miracle GRINDING MILL**.

One Hind & Lund steam jacketed DRYER, with "U"-shaped trough 5 ft. long.

One Broadbent under-driven HYDRO EXTRACTOR, self-balancing type, with self-contained A.C. motor.

Two FILTER PRESSES, fitted recessed C.I. plates, 40 in square, 2½ in. thick, centre fed, to make 11 cakes per Press.

One Lilleshall FILTER PRESS, fitted 18 C.I. plates, 36 in square, and 19 C.I. frames, with side inlet, side enclosed delivery and usual fittings.

Kek GRINDING MILL, square pin type, with grinding discs 13 in. diam., including circular delivery bin with single outlet.

Large unjacketed WERNER MIXER, belt and gear driven, hand tipping, double "Z" arms, pans 53 in. by 45 in. by 36 in. deep.

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No. 204 One **WERNER PFLEIDERER MIXER OR INCORPORATOR**, similar to the above, with a C.I. built pan 25 in. by 25 in. by 19 in. deep, belt pulleys 26 in. diam. by 5 in. face, double fin-type agitators, and mounted on C.I. legs.

No. 209 One **HORIZONTAL "U"-SHAPED MIXER**, steel built, riveted, measuring about 8 ft. 3 in. long by 3 ft. wide by 3 ft. 3 in. deep, with horizontal shaft, fitted with bolted-on mixing arms about 18 in. long by 4 in. wide, with intermediate breakers, and driven at one end by a pair of spur gears, with countershaft, fast and loose belt pulleys, outer bearing and plug cock type outlet at the opposite end, mounted on two cradles fitted to two R.S.J. running from end to end.

No. 210 One **HORIZONTAL MIXER** as above.

These three "U"-shaped mixers are in some cases fitted with steel plate covers and a steam jacket round the bottom and extending to within about 18 in. of the top with plain end plates.

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THE Proprietors of British Patent No. 644,910, dated 24th August, 1950 relating to "CONTINUOUS SOLVENT EXTRACTION PLANT" are desirous of entering into arrangements by way of a license or otherwise for the purpose of exploiting the above patent. Inquiries to MESSRS. MEWBURN, ELLIS & CO. 70 & 72, Chancery Lane, London, W.C.2.

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